IMPORTANT CONTRIBUTIONS by WALTER P. WORKMAN, M.A., B.Sc., Smith's Prizeman and Fellow of Trinity College, Cambridge; and Prof. J. REYNOLDS GREEN, M.A., D.Sc., Examiner in Botany to the University of Cambridge, will appear in our next issue.

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Science Supplement

To the PRACTICAL TEACHER, November, 1894.

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CHEMISTRY NOTES.

BY W. TATE, A.R.C.S., F.C.S.

THE object of these notes is to supply such aid to students acquainted with the simplest rudiments of their subject as will enable them to read the existing text-books profitably. The notes must necessarily be very short, and will generally treat of such matters as have not yet found their way into the ordinary text-books, or are there inadequately discussed. References will be given from time to time to publications in English, which may reasonably be expected to be accessible in well-found public libraries. These references will be, it is anticipated, of considerable assistance to the more advanced students who may, for instance, be reading with a view to entering for the Honours Stage in the Chemistry Examinations of the Science and Art Department, or for the London Degree Examinations. Questions will occasionally be set. Students who write out full answers to these questions will find that their labour will meet with its reward by the greater clearness and precision which their ideas will assume.

TEXT-BOOKS.—The number of the smaller text-books in Chemistry is legion, but very few of these are of such a character as would warrant a chemist in recommending their use to students. No one book treats this subject in a thoroughly philosophical manner and yet presents it within such bounds as to usefully *teach* its principles to the average student. Among the best of the works of moderate size is undoubtedly the recently issued 'Text-book of Inorganic Chemistry,' by G. S. Newth. The information it contains is reliable, clearly presented, and well up-to-date, with but a few trifling exceptions. For a student reading for the second stage examination (S. and A. D.) it is well-adapted. Those taking a somewhat wider range of work should read, in the first instance, 'Chemical Theory for Beginners,' by L. Dobbin and J. Walker, and the 'Introduction to Chemical Philosophy,' by Dr. W. A. Tilden. Later a different view of things may be obtained by studying the 'Text-book of Inorganic Chemistry,' by V. von Richter (trans. by E. F. Smith), and the two volumes of the 'Principles of Chemistry,' by D. Mendeléeff (trans. by G. Kamensky and edited by A. J. Greenaway). Students wishing to acquire some knowledge of Chemical Philosophy farther than the above books supply should read 'Modern Theories of Chemistry,' by Dr. Lothar Meyer (trans. by P. P. Bedson and W. C. Williams), and 'Outlines of General Chemistry,' by Dr. W. Ostwald (trans. by J. Walker). Finally the history of Chemistry is developed in 'A History of Chemistry,' by Dr. E. von Meyer (trans. by G. M'Gowan), and 'Essays in Historical Chemistry,' by Dr. T. E. Thorpe.

HISTORICAL NOTES.—Historical Chemistry is very generally either omitted from the smaller text-books, or only given in the shape of isolated notes, which escape attention. All students should be acquainted with the main outlines of the part played in the development of the science by Boyle, Lavoisier, Dalton, Liebig, and some few others of the more noted chemists. Again, current theories can be better appreciated by one who has some knowledge of the way in which the celebrated 'phlogiston'

theory arose and afterwards became discredited, and who can trace the advances from the dualistic theory of the composition of salts to the unitary theory at present holding sway. The evidence on which was founded the doctrine of chemical proportions, that which led to the atomic theory of the constitution of matter, and the progress of the theory of valency command especial attention. Brief notes on these matters will find a fitting place in our columns.

Robert Boyle was born in 1626 and died in 1691. He first came into notice through the publication at Oxford, in 1661, of a book entitled 'The Sceptical Chymist: or, Chemico Physical Doubts and Paradoxes touching the Experiments, whereby vulgar Spagyrists are wont to endeavour to evince their Salt, Sulphur, and Mercury to be the true Principles of Things.' Many of the facts quoted in this work owed their discovery to Boyle, for instance, the isolation of methyl alcohol from the material condensed on destructively distilling wood, and the preparation of acetone from the acetates of calcium and lead. He was the author of a number of pamphlets, such as his paper on the 'Saltness of the Sea and the Nature of the Sea's Bottom,' and the 'Essay of the Intestine Motions of the Particles of Quiescent Solids wherein the absolute Rest of Bodies is called in question.' He invented the air-pump, and devised numerous experiments to illustrate what he termed the 'Spring of the Air.' He discovered the law that the volume of a gas varies inversely as the pressure. The methods used for the investigation of the composition of substances were much improved by him. He criticised the various meanings attached to the term 'element' among his contemporaries, and rendered good service by limiting the term to the undecomposable constituents of bodies. His experiments on combustion and the formation of calces (oxides) by heating metals in the air gave results of great value, though, unfortunately, they were wrongly interpreted by himself. A corpuscular or atomic theory was brought forward by Boyle, but he did not arrive at quantitative relations between the particles of which he supposed substances to be formed. His influence on the development of chemistry was largely due to his advocacy of experimental methods of enquiry and his aversion to speculations having no basis in the observation of actual phenomena.

Henry Cavendish lived from 1731 to 1810. His work was very thorough and far in advance of that usual in his time, being particularly characterised by its quantitative character. He pointed out that water could be freed from its dissolved chalk by the addition of lime. We owe to him eudiometric methods of investigation of gases; indeed, Cavendish must be regarded as the founder of eudiometry and the chemistry of gases. His researches on inflammable air (hydrogen) proved it to be a gas differing from all others; incidentally he showed that a certain quantity of a metal always yielded the same amount of this gas whatever the acid used, and that the same weights of different metals gave different volumes of the gas. We are indebted to Cavendish also for the knowledge that atmospheric air is a *mixture* of nitrogen and oxygen in constant proportion, for the proof that water consists of hydrogen and oxygen, and for evidence regarding the composition of nitric acid.

Joseph Priestley was born in 1733, and terminated his very busy life in 1804. He was a most voluminous writer; a catalogue of his works drawn up after his death included 108 works, among which History and Theology found place together with publications concerning many departments of science. His chief contributions to Chemistry were connected with the discovery and preparation of new gases. Among those first investigated by him are: nitric oxide, nitrous oxide, carbonic oxide, sulphur dioxide, silicon fluoride, and, most important of all, oxygen. The last mentioned he prepared in 1774 by heating red precipitate (mercuric oxide) by means of solar heat concentrated by the aid of a burning glass. He first isolated hydrogen chloride and ammonia in the gaseous form. To the last he was an ardent supporter of the theory of phlogiston, yet his own brilliant experimental researches supplied much of the material for its refutation.

Practical Notes.—The detection of potassium may be readily and certainly carried out in simple cases as follows: Make a solution of the substance in dilute hydrochloric acid, filter if necessary, and pass a slow current of hydrogen sulphide through the clear hot solution till no further precipitate is formed. Filter, evaporate the filtrate to dryness with ammonium carbonate, and ignite gently; take up with a small quantity of water and repeat the evaporation with ammonium carbonate and ignition; again digest the residue with a little water and filter; concentrate the resulting filtrate to a few drops, add a very little hydrochloric acid, and then a few drops of platinic chloride solution and stir well with a glass rod. The characteristic yellow, heavy, crystalline precipitate of potassium platinum chloride will appear without the addition of alcohol.

The practical difficulty in the certain detection of aluminium in presence of iron and chromium arises from the almost invariable presence of aluminium in the sodium hydrate and sodium carbonate supplied to laboratories. This difficulty may be easily met by employing the following process: Dry the precipitate, which may consist of the hydrates of iron, chromium, and aluminium, and mix it intimately with four times its bulk of potassium nitrate; fuse the mixture on *platinum* foil and maintain at a bright red heat for ten minutes; boil the resulting mass in distilled water, and filter off any residue of ferric oxide; the solution will contain potassium chromate, potassium aluminate, potassium nitrite, and undecomposed potassium nitrate; divide into two parts; add to one part a drop of clear litmus solution, just enough hydrochloric acid to redden the litmus, and then a *dilute* solution of ammonia *drop by drop* until the litmus again becomes blue; a flocculent precipitate will appear carrying down the colouring matter of the litmus if aluminium be present (the ammoniacal solution should be boiled if more than the merest excess of ammonia has been added). The aluminate is decomposed on adding the acid, with formation of aluminium chloride, giving the usual reactions, and potassium chloride. The chromate does not interfere with the detection of the aluminium; it may be tested for in the reserved part of the solution by the addition of acetic acid and lead acetate, when a *yellow* precipitate (filter and wash before deciding the colour) indicates the presence of chromium. The precipitate of aluminium, chromium, and iron phosphates may be treated in exactly the same way. Owing to the presence of the phosphoric

acid, the aluminium shows up more readily in this case.

The detection of antimony and tin in the presence of arsenic often becomes a stumbling block in the path of unwary students. If the method here described be rigidly adhered to, no further difficulty should exist in the examination of this sub-group. Suppose a precipitate containing sulphides of arsenic, antimony, and tin, to be undergoing the process of washing. The presence or absence of tin may be readily proved by means of a borax bead coloured faintly blue with a trace of a copper salt. A bunsen burner is regulated to give a flame, rendered steady by its chimney, showing about one quarter of an inch of luminosity at the tip of the inner cone. The prepared copper bead is held in the reducing (luminous) flame for one minute; it will on cooling show no signs of red, even as streaks, although it may have become nearly colourless. The cool bead is dipped into the wet mixed sulphides, care being taken that a small portion of the precipitate adheres on its withdrawal; it is then strongly heated in the outer *oxidising* flame, until it assumes the original pale blue colour on cooling. This blue bead is again held for one minute in the luminous tip of the reducing flame; it will assume a red colour on cooling if tin be present, opaque if there be much tin, and only showing red streaks for traces only of tin.

Antimony may be specially examined for in the same sulphides precipitate by the very excellent film test here described. Wrap an asbestos thread round the end of a stout wire, and take up a portion of the wet mixed sulphides on the asbestos. Support a porcelain basin filled with water just above the extremity of a colourless bunsen flame. Burn off the sulphides completely from the asbestos holder; the oxides formed should, in part, collect as a dull, almost invisible, white sublimate on the lower surface of the basin. Remove the basin, moisten any white sublimate with solution of silver nitrate, and expose the moistened part to the fumes from concentrated ammonium hydrate. A black stain, insoluble in concentrated AmOH, indicates the presence of antimony. A yellow stain, readily soluble in AmOH, indicates the presence of arsenic.

The precipitate of mixed sulphides has been in the meantime thoroughly washed; it is now treated with hot concentrated HCl and filtered. The filtrate contains the antimony and tin as chlorides; it is freed from H_2S by boiling and divided into two parts; the one part is boiled with copper turnings, and the clear liquid added to a solution of mercuric chloride; a white heavy precipitate indicates the presence of tin; the antimony does not interfere, and is itself sought for in the second part by placing the solution in a basin with a strip of platinum foil in contact with a piece of pure zinc; a dark brown stain on the platinum indicates the presence of antimony. The evidence of this test is much inferior to that given by the film test described above. The undissolved residue from HCl consists of arsenious sulphide; it may be washed, and its nature confirmed by drying and heating in a bulb tube with KCN; a lustrous black mirror burning off with a garlic odour is sufficient to prove the presence of arsenic.

References.—The article 'Analysis,' in the new edition of Watts' 'Dictionary of Chemistry,' Vol. I., pp. 215–259, should be invaluable to students of Practical Chemistry.

In the same volume, 'Allotropy,' by Lothar Meyer, pp. 128–131, can be read by all with profit, the less advanced students confining themselves to the part headed 'Allotropy of the Elements.' The technology (including methods of manufacture) of ammonia, bromine, and chlorine, is fully set out in the articles by G. Lunge, in Thorpe's 'Dictionary of Applied Chemistry,' Vol. I.

Brin's oxygen process is described on pp. 85–87 of Thorpe's 'Dictionary of Applied Chemistry,' Vol. III.

Questions. *Advanced Stage.*—(1) What weight of hydrogen might be prepared by the action of a cwt. of iron nails upon steam in a red-hot tube, supposing the chemical change to be complete? (1893). (2) The specific heat of a certain metal is 0·031; what is approximately its atomic weight? What other facts would be required in order to establish its atomic weight with accuracy? (1894). (3) An unknown volume of hydrogen sulphide required 157 c.c. of chlorine for complete decomposition. What was the volume of the hydrogen sulphide? (1892). (4) One gramme of iron is converted into ferric chloride, and the product is dissolved in water. What volume, at normal temperature and pressure, of hydrogen sulphide is theoretically required to completely reduce the ferric chloride to ferrous chloride? (1891). (5) What weight of air, free from aqueous vapour and carbon dioxide, and containing 23 per cent. by weight of oxygen, is needed to burn 1 ton of coal of the following percentage composition:—

Carbon	81·5;
Oxygen	5·2;
Hydrogen	5·0;
Nitrogen	1·6;
Ash consisting of fully oxidised substances	6·7? (1894).

Advanced Practical.—(1) Describe and explain the effect of adding to solution of ferrous sulphate each of the following reagents:—Ammonium carbonate, ammonium sulphide, nitric acid (1894). (2) Describe and explain the cyanide process for separating nickel from cobalt (1894).

Honours Stage.—(1) One litre of mercury vapour at the standard temperature and pressure weighs 8·923 grammes. On heating 118·3938 grammes of mercuric oxide, Erdmann and Marchand obtained 109·6308 grammes of mercury. On the assumption that mercuric oxide is formed by the union of 1 atom of mercury with 1 atom of oxygen, what light do these facts throw on the atomic and molecular weights of mercury? (1891). (2) The absorption coefficient of nitrogen dissolved in water at 12·6° is 0·0152. What volume of the gas (measured at 0° and 760 mm.) is absorbed by 1 litre of water at 12·6° at each of the following pressures:—1,000 mm., 748·2 mm., 391 mm., and 14·3 mm.? (1892). (3) Write a brief history of the theory of phlogiston, with an account of the discoveries which finally led to its rejection (1891). (4) What influence had the phlogistic theory on the progress of chemistry? Why was the antiphlogistic theory incomplete before the composition of water was known? (1894).

Remarks on the preceding questions will appear in a subsequent issue.

Enquiries concerning chemical matters of interest to students will be replied to in these columns so far as space may allow.

HONOURS PHYSIOGRAPHY NOTES.

BY H. G. WELLS, B.SC. (LOND.),
Fellow (in Honours) and Doreck Scholar of the College of Preceptors.

The Density of the Earth.

An account of Professor C. V. Boys' researches to determine the constant of gravitation, and, consequently, the earth's density, has lately been published. Professor Boys has had the investigation under way since 1889, but it was only in June last that he gave a complete description of the apparatus employed and results obtained at the Royal Institution. His lecture is printed in *Nature* of August 2, 9, and 23.

The principle of the experiment made by Cavendish to determine the earth's density is explained in 'Advanced Physiography,' p. 94. Cavendish measured the force of attraction between two balls of lead, one 12 inches and the other two inches in diameter, and with their centres 8·85 inches apart. The same experiment has since been made by Reich, by Baily, and in recent years by Cornu and Baille with greatly superior apparatus of one quarter of the size. Professor Boys reduced the dimensions of the apparatus to one-eightieth. Cavendish had a force equal to $\frac{1}{3600}$ grain's weight to measure; Professor Boys had less than a five-millionth. But one advantage gained by the use of small apparatus is the increased sensibility, that is to say, the greater angle of deflection produced by the attractions, when the period of oscillation of the beam connecting the attracted balls is the same. The greatest advantage, however, is that there is much less disturbance from air currents than when large apparatus is employed. Instead of the massive lead balls used by Cavendish, Professor Boys employed lead balls 4¼ and 2¼ inches in diameter. The two spheres which were attracted by these balls were made of gold, and the minute beam connecting them was suspended by fine quartz fibres. Both the lead and the gold balls were perfectly spherical in form, and homogeneous. The gold balls were 0·2 and 0·25 inch in diameter. A very light mirror was fixed vertically to the beam carrying these balls, so that when the balls were attracted, and the beam was consequently deflected from its position of rest, the mirror was also turned. The movement of a slit of light reflected by the mirror thus enabled the deflection of the rod carrying the balls to be determined. Measurements made with this apparatus led Professor Boys to conclude that the mean density of the earth is 5·5270 times that of water.

The following table, from Professor Poynting's recently published book, 'On the Mean Density of the Earth,' shows the results previously obtained:—

Approximate date.	Experimenter.	Method.	Resulting Density.
1737–40	Bouguer	Plumb-line and pendulum	Inconclusive
1774–76	Maskelyne and Hutton	Plumb-line	4·5–5
1855	James and Clarke	,,	5·316
1821	Carlini	Mountain pendulum	4·39–4·95
1880	Mendenhall	,,	5·77
1854	Airy	Mine pendulum	6·565
1883	Von Sterneck	,,	5·77
1885	Von Sterneck	,,	About 7
1797–98	Cavendish	Torsion balance	5·448
1837	Reich	,,	5·49
1840–41	Baily	,,	5·674
1852	Reich	,,	5·583
1870	Cornu and Baille	,,	5·56–5·50
1879–80	Von Jolly	Common balance	5·692
1878–90	Poynting	,,	5·493 (5·46–5·52)
1884	König, Richarz, and Krigar Menzel	,,	In progress
1886–88	Wilsing	Pendulum balance	5·579
1889	Laska	,,	In progress

Variations in the Number of Meteors.

The average number of shooting stars observable increases from the evening to the morning hours. This increase is due to the rotation of the earth and to the fact that the front of the earth in her orbital motion encounters more shooting stars than the back, as the front of a man's hat who moves through rain will get wetter than the back, and this in proportion to his speed. Mr. George C. Bompas, in an important paper in the June number of the Monthly Notices of the Royal Astronomical Society, explains this horary variation of meteors, and brings out some new points with regard to a semi-annual variation. At 6 p.m., he says, the spectator stands at the back of the earth, and looks back on the track already traversed. The earth's rotation carries him round hour by hour until at midnight he enters the front hemisphere, and is again carried round until at about 6 a.m. he reaches the foremost meridian of the earth in her motion along her orbit. To this chiefly is due the variation in the number of meteors from hour to hour.

'It is a saying of Arago,' wrote Professor A. S. Herschel thirty years ago, 'founded upon observation and confirmed by constant experience in later years, that the earth encounters more shooting stars in going from aphelion to perihelion than in going from perihelion to aphelion.' The fact of this semi-annual variation in the number of meteors has since been confirmed by many observers, and has also furnished a subject for much discussion. Mr. Bompas criticises the explanation believed to account for the facts of observation. The theory accepted by most observers is that the semi-annual variation referred to is due to the planetary motion of the earth, just as the horary variation is due to the earth's rotation. It will at once be seen that observations in the southern hemisphere supply a test of the validity of this explanation; for the greater number of meteors should appear in the southern hemisphere from January to June in each year—that is, when that hemisphere is in front of the earth's orbital motion. From June to December, when the northern hemisphere is in front, we encounter a larger number of meteors than during the first half of the year. There can be no doubt that the change in the position of the earth's axis relatively to her motion does really tend to increase the number of shooting stars seen in the second half of the year in the northern hemisphere, but Mr. Bompas thinks that this cause is insufficient to account for the very large increase observed, viz., from two to three times the number observed in the first half of the year. He has examined the meteor observations made by Dr. Neumayer at the Melbourne Observatory from 1858 to 1863, and he finds that the variation is not reversed, but follows the same law as in the northern hemisphere, the hourly number of meteors seen in the second half of the year exceeding the number seen in the first half. It seems, therefore, that some cause further than that hitherto assigned must help in producing the semi-annual variation of meteors. The whole discussion leads Mr. Bompas to submit: (1) That the explanation hitherto adopted of the semi-annual variation of meteors is inadequate; (2) that the variation is connected with and mainly due to the cosmical motion of the solar system; (3) that it renders highly probable the cosmical origin and motion of meteors.

The Distribution of Nebulæ and Star-Clusters.

Mr. Sidney Waters has mapped all the nebulæ and star-clusters contained in the standard catalogue, with the object of showing their distribution in the heavens. The maps are published in the Monthly Notices of the Royal Astronomical Society for June. They show that star-clusters are most numerous near the Milky Way; indeed, it is striking to note the fidelity with which they follow out not only the main track of the Milky Way, but also its convolutions and streams. Nebulæ, however, are most numerous away from the Galaxy, and Mr. Waters points out that the remarkable avoidance of the Galaxy by the nebulæ, although in some points nebulæ reach up to and encroach upon its edges, is equally significant with the coincidence of the clusters with its main track. (See Gregory's 'Advanced Physiography,' p. 218.)

The Velocity of an Earthquake.

From a discussion of the observations of the earthquake which caused so much damage in Constantinople in July, Mr. C. Davison has determined the velocity of the pulsations (*Nature*, Sept. 6th). The earthquake was recorded upon the instruments at a number of observatories, and knowing the distances of these stations from the centre of commotion, as well as the times at which the movements were registered, the velocities could be calculated. The average velocity of the large pulsations, obtained from the different records, was 3·4 kilometres (= 2·1 miles) per second. The depth of the seismic focus, that is, the centre from which the waves spread, has been found to be about twenty-one miles.

GENERAL NOTES.

Protection from Lightning.

The U.S. Weather Bureau has issued a useful circular on protection from lightning, drawn up by Mr. Alex. McAdie. From the statistics collected, it appears that lightning is more apt to strike in the country than in cities, the risk in the country being five times greater than in the city. Lightning rods have a two-fold function—to conduct the charge of electricity to the earth, and to prevent or modify the violence of the discharge by a silent neutrali-

sation of the electrification of the clouds. In order to carry the lightning flash, Mr. McAdie points out that the lightning conductor should offer a line of discharge more nearly perfect, and more accessible than any other offered by the materials or contents of the edifice which it is desired to protect, and, in order to prevent the discharge, the conductor should be surrounded by points. He has something to say with regard to a few of the popular superstitions about lightning. For instance, contrary to the general opinion, there are many cases of lightning striking twice in the same place. Small articles of steel, and mirrors also, have not the power of *attracting* lightning, as is popularly supposed, or of determining the path of discharge. In the way of cautions, it is remarked that it is not judicious to stand under trees during thunderstorms, in the doorway of barns, close to cattle, or near chimneys and fire-places. On the other hand, there is not much sense in going to bed, or trying to insulate one's self in feather beds.

The Transmission of Acquired Character.

Prof. Havelock Charles has made a detailed investigation of the differences between the leg-bones of Europeans and those of the Punjaub people—differences caused by their respective habits of sitting in chairs and squatting on the ground. The habits as to sitting postures of Europeans differ from those of their pre-historic ancestors, the cave-dwellers, etc., who probably squatted on the ground. On the other hand, the sitting postures of Orientals are the same now as ever. These races have retained the habits of their ancestors, whereas the Europeans have not done so. Prof. Charles has found, on the Punjaub child and foetus, facets on their bones fitting them for postures of rest practised by the Punjaubi. But want of use induces changes in form and size, and the result is that these facets have totally disappeared on the European skeleton. The obvious conclusion is that the markings are instances of the transmission of acquired characters. As a good deal of discussion has been carried on over the question of the transmission of peculiarities, Prof. Charles' investigation has excited great interest. His observations certainly indicate that it is possible for an acquisition to eventually become a permanent possession of a racial type.

The Age of the Niagara Falls.

At the last meeting of the American Association for the Advance- of Science, Prof. Spencer described the evolution of the Niagara Falls. According to him, the beginning was a little stream draining the Erie Basin and falling only about 200 feet over the Niagara escarpment. This stream was not over one-fourth the present volume of the great cataract, and consequently was able to excavate the gorge at a much lower rate than at present. During this early history of the river, the waters of the three upper lakes emptied through the Huron Basin by way of the Ottawa River. The height of the Falls has advanced several times, and, owing to this change and the variation in the discharge of the water, retreat of the Falls has varied greatly during changing episodes. The computations of the age have been based upon these changing conditions of elevation and downfall of the river. The first episode, as before stated, represented a small river, with a total fall of 200 feet. This lasted about 11,000 years. Then came another episode, where the height of the Falls was increased from 200 to 400 feet, succeeded by the entire drainage of all the upper Great Lakes. At the same time there were series of three cascades, the lower gaining on the upper, until finally they were all united in one great cataract, much higher than that of the present time. Subsequently, the waters were raised at the head of Lake Ontario so as to bring about the present condition after a lapse of 17,000 years from the end of the first episode. The last or modern episode has lasted 3,000 years under nearly the present conditions. Thus we see that the age of the Falls is about 31,000 years, with another 1,000 years added for an earlier condition not given. It is now 8,000 years since Lake Huron emptied into Lake Erie for the first time, and there is reason to believe that, on account of the rise of the land about the outlet of the latter, in 5,000 or 6,000 years the waters of the four upper lakes will be turned into the Mississippi drainage at Chicago.

MAGNETISM AND ELECTRICITY.

FOR THE ADVANCED STAGE OF THE SCIENCE AND ART DEPARTMENT COURSE.

BY EDWIN EDSER, A.R.C.S.

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It is proposed in these columns to indicate a course of study suitable for those preparing for the Advanced Stage Science and Art Examination in Electricity and Magnetism. Space would not permit of a detailed treatment of the subject; so the plan adopted is to recommend a text book, and in that to prescribe a certain amount to be read per month, at the same time explaining or amplifying those parts which are considered to need this treatment. Finally, questions to be answered by the student will be set.

The book recommended is 'A Text-book of Magnetism and Electricity,' by R. Wallace Stewart, B.Sc.; published by the University Correspondence Press, 13, Booksellers Row, Strand, W.C. Price 5s. 6d.

It is important to bear in mind that the part of science which is most fruitful in the cultivation of the intellect is the grasping and careful following up of principles, and not in any random committal to memory of isolated facts. In what follows, therefore, we shall emphasize the former, and endeavour to dissuade the student from the useless and laborious practice of 'cramming up' tables, etc.

Electrical Attraction and Repulsion (*par.* 6, *p.* 15).—The earlier part of the book contains nothing that will not be readily comprehensible to the student; but a few words to explain the law of attraction as described in this paragraph may not be amiss.

As stated, the magnitude of the force acting between electrified bodies can be expressed as follows:—

$$f = \frac{1}{k}\,\frac{qq^1}{d_2},$$

where f = the force acting, which, when positive, indicates repulsion; k a constant, depending on the medium in which the electrified bodies are placed; q and q^1 represent the quantities of electricity on each body, and d = their distance apart.

A simple explanation of this formula may be given on the principle of *lines of force*. When two bodies attract or repel each other, it is necessary to imagine some sort of mechanism or connection extending between them, by which means the attraction or repulsion is transmitted. As we shall see later, there is ample cause to suppose that it is the *luminiferous ether* which in some way transmits this force; and we can imagine strings of ether proceeding regularly from all points of an electrified body, and extending radially from it into space. Now, suppose we define the *unit quantity of electricity* as that which when placed on a small sphere in air will cause 4π lines of force to thus proceed from it.

It is obvious that, supposing each of these strings to act as an elastic filament, drawing in any body attached to its end, the force of attraction will be proportional to the number of filaments attached to it; in other words, the force of attraction at any point will be proportional to the number of lines of force per unit area at that point.

Now consider the state of the lines of force at a distance from the small electrified sphere. If, according to our previous supposition, one unit of electricity be placed on the sphere, there will be 4π lines of force radiating from it. Now construct about this small sphere as centre a sphere of radius d; then the lines of force will pass normally through this surface and be uniformly distributed over it, and the attraction at any point will depend on the number of lines of force per unit area around that point.

There are 4π lines of force scattered over surface of sphere, of area a; therefore number of lines of force per unit area $= \frac{4\pi}{a}$.

But the area of the surface of a sphere of radius $d = 4\pi d^2$

$\therefore$ number of lines of force per unit area $= \frac{4\pi}{4\pi d^2} = \frac{1}{d^2}$

Considering lines of force as elastic bands, only attractions could be accounted for; but to explain repulsions it is necessary to suppose lines of force extending from one positively electrified body to another similarly electrified, to have the property of extending so as to push the two bodies apart. Exactly the same reasoning applies in this case, so that we reach the generalization that *the attractions or repulsions of two electrified bodies vary inversely as their distance apart.*

If we now suppose q units of electricity placed on one body, there will be $4\pi q$ lines of force radiating from it; consequently the repulsion on one unit of electricity placed at a distance d from it will be $\frac{q}{d^2}$. If we suppose that there are q^1 units instead of one at the point, there will be a force of $\frac{qq^1}{d^2}$, so that we see that the *force between two electrified bodies varies as the quantities of electricity on each.*

Lastly, we come to the consideration of the constant k. This constant, as before stated, depends for its value on the nature of the medium in which the electrified particles are placed. If k be more than one, we might consider the action of the medium either as decreasing the number of lines of force proceeding from the body in the ratio $\frac{1}{k}$, or as weakening the pulling or pushing force of each

line. The former is perhaps the most instructive way of looking at the matter. k is taken as 1 for air.

Finally, then, we have the equation for the force between two electrified bodies, $= f = \frac{1}{k}\frac{qq^1}{d^2}$.

(*Par.* 10, *p.* 25.) The student should carefully work through examples (1–4). To fully understand these examples, and to grasp the meaning of the units used, a few words on physical units may prove useful to the beginner.

There are three fundamental units used in physical measurements, *viz.*, the *centimetre*, the *gramme*, and the *second*, these being the units of *length*, of *mass*, and of *time* respectively.

The *centimetre* is a certain length marked off on a bar of platinum kept at Paris. It was founded on theoretical considerations, but the truth or falsehood of these in no wise affects its value as a practical unit at the present day.

The *gramme* is the mass of 1 cubic centimetre of water at the temperature of 4°C.

The *second* is the unit of time, and is fixed by the time of swing of a pendulum of a given length at a given point on the earth's surface.

From these three units it now becomes necessary to obtain units of force, velocity, etc., which can then be applied to obtain still other units used in physical measurements.

Suppose a body to move uniformly, and that it describes a distance of n centimetres in t seconds, then it evidently describes $\frac{n}{t}$ centimetres in one second.

We now define *unit velocity as that of a body moving* 1 *centimetre per second.*

Force is measured by the alteration of velocity of a body acted on by it. If a body of unit mass be moving with a velocity v, and t seconds afterwards at the velocity v^1, then the alteration in t seconds $= v^1 - v$; $\therefore$ the alteration or acceleration of velocity in 1 second $= \frac{v^1 - v}{t}$. Reasoning as above, we get the definition of the *unit force* (called the *Dyne*) as that force which, acting on a body of unit mass, accelerates its velocity in the direction of the force by 1 unit of velocity per second—that is, by one centimetre per second per second.

This unit force, then, the dyne, is based on mechanical considerations, and has been determined accurately. Thus 1 gramme of matter is attracted towards the centre of the earth with a force of about 981 dynes.

Let us now apply this unit of force to our electrical units. Let us define our unit electrical force as 1 dyne; then it follows that if unit quantity of electricity be placed on each of two small spheres, and placed in air at such a distance apart that the force between them is 1 dyne, we have, substituting in the formula

$$f = \frac{1}{k}\frac{qq^1}{d^2},$$

$$1 = \frac{1}{1} \times \frac{1 \times 1}{d^2} = \frac{1}{d^2}\ ;\ \therefore d = 1.$$

From this springs our definition of *unit quantity of electricity*, viz., *a quantity such that when placed on a small sphere* 1 *centimetre distance from an equal quantity placed on another small sphere, they will repel one another with a force of* 1 *dyne.*

With the above understanding, examples 1 and 2 will be easily solved by the student. No. 3 involves the definition of *unit field*, which is such *that there is* 1 *line of force per square centimetre* at the point, or, what, as already explained, is the same thing, such that a *unit charge placed at that point experiences a force of* 1 *dyne.*

Ex. 5 is not of so much importance; ex. 6 will easily be solved; but exs. 7, 8, 9 require a knowledge of a further principle, viz., the *parallelogram of forces.* The problem referred to is as follows:—

'Two charges of + 10 and — 10 units are placed at two corners of an equilateral triangle of 10 cm. side. Find the magnitude and direction of the resultant force acting on a charge of + 10 units placed at the third corner of the triangle.'

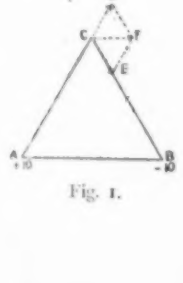

Fig. 1.

Fig. 1 represents the distribution of the charges, + 10 units at A and — 10 units at B. We must now find the magnitude and direction of the force due to these two charges acting on + 10 units placed at C.

Each charge at A and B respectively will exert an independent force on the + 10 units at C; we will now represent these forces in magnitude and direction by straight lines. The + 10 units at A will exert a force at C represented by

$$\frac{(+10) \times (+10)}{(10)^2} = 1 \text{ unit of force, or 1 dyne,}$$

in the direction AC. Let us represent this by the line CD. The — 10 units at B will exert a force on the + 10 units at C equal to

$$\frac{(-10) \times (+10)}{(10)^2} = -1\ ;$$

this we will represent by a line CE, equal in length to CD, but measured along CB. Note particularly that the + force, denoting repulsion, is represented by a line measured *away* from A, whilst the — force, denoting attraction, is represented by line measured *towards* B.

The + 10 units placed at C are therefore acted on by these two forces; it is required to find the magnitude and direction of their resultant, *i.e.*, a single force which would have the same effect as the two given forces combined.

This can be done by the aid of a proposition called the *parallelogram of forces*, viz., *If two forces be represented in magnitude and direction by two straight lines proceeding from the point where the forces act, the resultant force will be represented in magnitude and direction by the diagonal, drawn from the point where the forces act, of the parallelogram of which the above two lines form adjacent sides.*

To find, then, the resultant of the forces represented by CD and CE, complete the parallelogram CDFE, and draw from C the diagonal CF. Then CF represents in magnitude and direction the resultant force required.

To calculate the numerical value of this force in dynes, remember CD = 1, CE = DF = 1, and the three sides CD, DF, and FC of the triangle CDF can be seen by simple geometrical reasoning to be parallel to AC, CB, and BA respectively. Therefore the triangle CDF is equilateral, and CF = CD = 1. Therefore the resultant force = 1 dyne acting in the direction CF.

The student should now work out the problem for the case of — 10 units placed at A, and — 10 at B; also + 10 at A, and + 10 at B. These problems will present no difficulty if the signs of the forces be attended to, and their magnitude and direction be represented according to the above convention.

We are now in a position to find the *field of force* due to two charges of electricity placed at definite points. We have already come to understand the meaning of the electrical field in case of a single charge, and we now adopt the convention of defining the lines of force due to two charges, as curves such that a tangent drawn to one of them at any point will represent the direction of the resultant force at that point.

Let it be required to find the lines of force due to + 10 units at A, and — 10 units at B. Our mode of procedure is to take a point

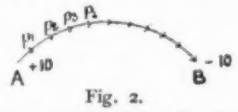

Fig. 2.

p_1, near to A (Fig. 2), and to find the direction of the resultant force precisely as we have done in the above example. Draw a short line p_1p_2 in this direction, and then in a similar manner find the resultant force at p_2. Draw p_2p_3, and proceeding in this way a continuous curve will ultimately be drawn extending from A to B. *This curve represents a line of force.*

(The student is recommended to read chapters I.–III., and to work through the examples to chapter I.)

MATHEMATICS.

STAGES 2 AND 3, SCIENCE AND ART DEPARTMENT.

By G. A. Baxandall,

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With this issue we commence a series of articles dealing with the work necessary for the above-mentioned stages, so it may be well to briefly explain the method to be adopted.

For each part of the subject text-books are recommended, the necessary chapters and articles which the student must read being given each month. Then follow the examples to be worked out, some being selected from the text-books, and the rest from different sources, including past examinations. The answers to these will generally be attached, while hints and solutions of a few will be given the following month.

STAGE 2.

The text-books we shall refer to are—Hamblin Smith's 'Elementary Algebra' (with answers), or Hall and Knight's 'Elementary Algebra;' Hamblin Smith's 'Elementary Trigonometry,' or Lock's 'Elementary Trigonometry'; Todhunter's 'Euclid,' or any other modern edition containing Euclid's first three books. We now append the work for the month.

Algebra.

Read the chapter on Square Root, and the one on Surds.

Work out the following examples :—

Find the square root of

1. $x^4-6x^3+19x^2-30x+25$. Ans. x^2-3x+5.
2. $25x^4y^2-30x^3y^3+29x^2y^4-12xy^5+4y^6$.
   Ans. $5x^2y-3xy^2+2y^3$.
3. $4x^2(x^2-y)+y^2(y-2)+y^2(4x^2+1)$.
   Ans. $2x^2-y+y^2$.
4. $\frac{4m^2}{n^2}+9\frac{n^2}{m^2}+4-16\frac{m}{n}+24\frac{n}{m}$. Ans. $\frac{2m}{n}-4-\frac{3n}{m}$.
5. $\{(3x+2y)^2+(x-4y)^2\}^2-4(3x+2y)^2(x-4y)^2$.
6. $a^2-2mab+4ac+m^2b^2-4mbc+4c^2$.
7. Reduce as far as possible the quantities under the root sign in $\sqrt{50}$; $\sqrt{720x^2}$; $18\sqrt{\frac{5}{27}x^3}$ and $\sqrt[3]{108m^9n^{10}}$.

   Answers. $5\sqrt{2}$; $12c\sqrt{5}$; $6x\sqrt{\frac{5x}{3}}$; $3m^3n^3\sqrt[3]{4n}$.

8. Reduce to complete surds :

   $5\sqrt[3]{9}$; $2ax\sqrt{\frac{3a}{4x}}$; $\left(\frac{x-y}{x+y}\right)\left(\frac{x^2+xy}{x^2-2xy+y^2}\right)^{\frac{1}{2}}$.

   Answers. $\sqrt[3]{1125}$; $\sqrt{3a^3x}$; $\sqrt{\frac{x}{x+y}}$.

9. Multiply $\sqrt{a-4}-7$ by $\sqrt{a-4}+7$.
   Ans. $a-53$.

   $\sqrt{x}+\sqrt{y}+\sqrt{z}$ by $\sqrt{x}-\sqrt{y}+\sqrt{z}$.
   Ans. $x-y+z+2\sqrt{xz}$.

10. Simplify $\frac{\sqrt{a}}{\sqrt{a}-\sqrt{b}}$; $\frac{2-\sqrt{2}}{2+\sqrt{2}}$; and if $2x-5=\sqrt{13}$, get the value of $\frac{(x-5)(x-1)}{(x-3)}$.

    Answers. $\frac{a+\sqrt{ab}}{a-b}$; $3-2\sqrt{2}$; $\frac{\sqrt{13}+7}{6}$.

Trigonometry.

Observe the relation between the circumference of a circle and its diameter, viz. :—

$\frac{\text{circum.}}{\text{diam.}}=\pi=\frac{22}{7}$ or, correct to 5 places, 3·14159.

Read the chapter on the Measurement of Angles, carefully noting the definitions of the circular measure of any angle and of the unit angle, also the magnitude of the unit angle. In particular, remember the circular measure of 180°, and hence of angles which are multiples or sub-multiples of 180°. Learn the definitions of the trigonometrical ratios of any angle.

Work out the following examples :—

1. What is the numerical measure of two right angles in circular measure? If one of the acute angles of a right-angled triangles is 1·2 in circular measure, what is the numerical value of the other angle, (*a*) in circular measure, (*b*) in sexagesimal measure (degrees, minutes, etc.)?
   Ans. (*a*) ·371; (*b*) 21° 16′ 21″·8.

2. Define the radian or unit angle in circular measure, and write down in a decimal form, true to five places, the value of the ratio of the circumference of a circle to its diameter. Find, as accurately as you can, the numerical value in circular measure of 45° and of 25° 10′.
   Answers. (1) 3·14159; (2) ·78539; (3) ·439.

3. What are the numerical values of a right-angle in circular measure and in sexagesimal measure? Find in circular measure the numerical value of an angle of 37° 15′. The radius of a circle being 105 feet, find the length of arc which subtends an angle of 37° 15′ at the centre.
   Answers. $\frac{\pi}{2}$; 90°; ·6504; 68·29 ft.

4. What is meant by the circular measure of angles, and what is the unit of circular measures? Given an angle in circular measure, how is its value in sexagesimal measure found? An angle is $\frac{3}{5}$ in circular measure, what is it in degrees, minutes, and seconds. Ans. 38° 10′ 54″·5.

5. ABC is a triangle right-angled at C. If AC = 3 and CB = 4, write down the numerical values of all the trigonometrical ratios for the two acute angles. If CA be produced to D so that the AD = AB, write down the values of the trigonometrical ratios for the angles CDB, CBD.

6. ADCD is a square 12 inches long. A point E is taken between A and B so that BE = one-half EA. If O be the centre of the square, find the values of the sine, secant, and cotangent of the angle AEO. Answers. $\frac{3}{\sqrt{10}}$; $\sqrt{10}$; $\frac{1}{3}$.

Geometry.

Read propositions 1 to 8, Book II.

Try the following riders :—

1. Show that the square on the sum of two straight lines together with the square on their difference is double the squares on the two straight lines.

2. Construct a rectangle equal to the difference of two given squares.

STAGE 3.

For this stage we recommend the following text-books :—Either Todhunter's 'Larger Algebra,' or Hall and Knight's 'Higher Algebra;' although the latter is the better book of the two. For Trigonometry, Todhunter's 'Plane Trigonometry,' Lock's 'Higher Trigonometry,' or Loney's (large book) 'Trigonometry,' will suffice; although the latter is probably the best published. We shall, however, as far as is considered necessary, give instruction in some parts of the work which may not appear in one or the other of the books just mentioned. We shall now append the work for the month.

Algebra.

Read Articles 139–151, and 153, 156, in Hall and Knight; or Articles 487–498 in Todhunter, omitting 496 for the present.

Referring to Hall and Knight, we advise the student to dwell on Article 140, as this principle is of fundamental importance. It is directly applied in establishing many of the formulæ, and one should be always ready to apply it to any example rather than work blindly from the formulæ.

Of the methods in Articles 141 and 143, Hall and Knight, probably the former will appear more satisfactory.

Work out 6, 13, 17, 25, Examples XI.*a*, and 5, 10, 16, 28, Examples XI.*b*, in Hall and Knight; or 8, 9, 12, 26, 29, 36, Examples XXXIV., Todhunter.

Also the following :—

1. Twenty different letters are to be distributed among 4 persons, giving five to each; in how many ways can this be done? Ans. $\frac{\lfloor 20}{\lfloor 5 \rfloor^4}$.

2. At a game of cards, three being dealt to each person, any one can have 425 times as many hands as there are cards in the pack; find number of cards. Ans. 52.

3. Out of 20 men who have to sit down, half on each side of a long table, 4 men desire to sit on one side, and 6 others to sit on the other side; find the number of ways in which this can be done. Ans. $\frac{\lfloor 10 \rfloor^2}{\lfloor 4 \rfloor \lfloor 6}$.

4. There are 7 exactly similar groups of 11 things (*a*, *b*, *c*, etc.). In how many ways can 7 things be taken one out of each group, consistently with one particular thing (*e.g.*, *a*) being taken twice, neither more nor less? What would the result be if there were *m* groups of *n* things each, and one particular thing were taken *p* times?

Example.—There are 4 regular polyhedrons marked, each with a different symbol, the numbers of their faces being 4, 6, 8, 12, re-

spectively; taking all of them together, how many different throws are possible?

Solution.—Consider the first polyhedron; the operation of throwing it can be performed in 4 different ways, for any one of the faces may turn up. When this operation has been performed in any one way, there are 6 ways of performing the operation of throwing the second polyhedron; hence according to the principle referred to above, there are $4 \times 6 = 24$ ways of performing the operation of throwing 2 polyhedrons; and, therefore, by an extension of this reasoning, the total number of throws $= 4 \times 6 \times 8 \times 12 = 2304$.

Example.—Three persons have 4 coats, 5 vests, and 6 hats between them; in how many different ways can they dress themselves with them?

Solution.—Consider any one man; he may select a coat in 4 ways, a vest in 5 ways, and a hat in 6 ways; and, therefore, by the fundamental principle, he can dress himself in $4 \times 5 \times 6 = 120$ ways. Now when he has dressed himself in any one of these ways, a second man can choose a coat in 3 ways only, a vest in 4 ways, and a hat in 5 ways; that is, he may dress himself in $3 \times 4 \times 5 = 60$ ways. Again, therefore, by the principle, two men may dress themselves in $120 \times 60 = 7200$ ways, and when they have done so in any one of theseways, the third man can dress himself in $2 \times 3 \times 4 = 24$ ways; and, therefore, the required result is $120 \times 60 \times 24 = 172800$ ways.

Trigonometry.

Read from any of the text-books the articles which deal with the area of a triangle (three formulæ) and the radii of the circles inscribed in or circumscribed about a given triangle.

Work out the following examples, in which the letters have the usual meanings, viz., R, r r_a r_b r_c, for the radii of the circumscribed, inscribed, and escribed circles respectively, S being the area of triangle.

Prove that:—

1. $2Rr = \dfrac{abc}{a+b+c}$.
2. $16R^2 r r_a r_b r_c = a^2 b^2 c^2$.
3. $rr_a = S$, where a is one side of a triangle right-angled at C.
4. $r_a r_b r_c = abc \cos\dfrac{A}{2} \cdot \cos\dfrac{B}{2} \cdot \cos\dfrac{C}{2}$.
5. $4S = (a+b+c)^2 \tan\dfrac{A}{2} \cdot \tan\dfrac{B}{2} \cdot \tan\dfrac{C}{2}$.

The lengths of the tangents from a corner of the triangle to inscribed or escribed circle are useful, and may be found as follows:—

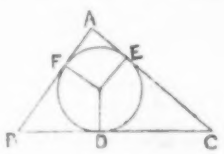


FIG. 1.

The six tangents = perimeter $= 2s$; $\therefore$ three different tangents,

$$AE + CD + BD = s;$$
$$\therefore AE + a = s;$$
$$\therefore AE = s - a.$$

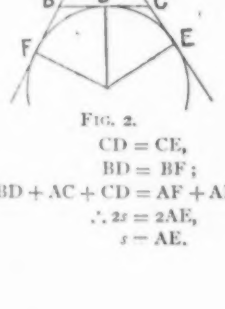


FIG. 2.

$$CD = CE,$$
$$BD = BF;$$
$$\therefore AB + BD + AC + CD = AF + AE = 2AE;$$
$$\therefore 2s = 2AE,$$
$$s = AE.$$

Euclid.

In the Third Stage a thorough knowledge of the first three books of Euclid is required, a couple of riders being generally set on them. We can, therefore, only ask the reader to work out as many riders as his time permits of. A few riders will be given each month, and their solutions will appear in the following issue.

Try the following riders:—

1. If two equal circles are given intersecting in A and B, and if any straight line be drawn through either of these points to meet the circles in C and D; find the locus of the middle point of CD.
2. C is the point of contact of two circles which touch each other internally, and CPQ is a straight line, cutting the inner circle at P and the outer circle at Q; the tangent to the inner circle at P cuts the outer circle at A and B; show that the arc AQB is bisected at Q.

BIG TELESCOPES AND THEIR USE.

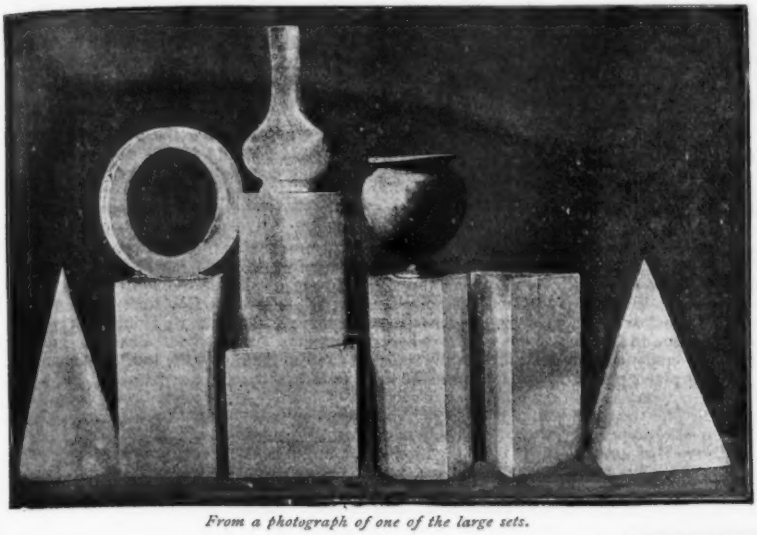
BY RICHARD A. GREGORY, F.R.A.S.

Oxford University Extension Lecturer. Author of 'Elementary Physiography,' etc.

By looking through two spectacle lenses held a short distance apart, objects can be made to appear nearer. The story goes that a child's exclamation of wonder at the appearance of a church spire, when viewed under these conditions, attracted the attention of a spectacle-maker in Holland about 1688, who afterwards utilised the principle in the construction of the first telescope. The instrument, like that used by Galileo, had an arrangement of lenses precisely similar to those in a sixpenny telescope or a common opera-glass, and, compared with the means now at the disposal of astronomers, was a very feeble affair. However, such optical aid enabled Galileo to see spots on the sun, to discover four moons revolving round the planet Jupiter, and to observe that Venus changes from half to full and so on, just like our moon. A new kind of astronomy was thus founded. Before the invention of the telescope, the positions and motions of the heavenly bodies were the subjects of study; after, it became possible to inquire what the objects are in themselves.

Although a modern astronomical telescope, with its numerous and complicated accessories, differs very considerably in appearance from the simple instrument used by Galileo in his scrutiny of celestial objects, the optical principles underlying the two are much the same. Both consist essentially of a large lens (termed the objective) to form an image of the object under examination, and a small lens, or combination of lenses (known as the eye-piece) to magnify the image. If the functions of these glasses are properly understood, the power of an astronomical telescope to see faint objects and to magnify them can always be estimated. Consider first the use of the objective. Rays of light, which produce in us the sensation of sight, can only enter our eyes through the pupil. Increase the size of the pupil, and the amount of light received is increased in the same proportion. This can easily be proved by noticing the size of the pupils of a cat's eyes at different times. During the bright light of day, the iris will be seen to contract and so diminish the size of the pupil. As the light fades, however, the pupil increases in size so as to grasp as many rays as possible. Now, the average diameter of the pupil of the human eye is one-fifth of an inch. With a pupil as big as a halfpenny, twenty-five times more light would be collected than under ordinary circumstances. In the same way, the brightness of an object observed in a telescope depends upon the surface of the objective. A lens ten inches in diameter shows a star 2,500 times brighter than if seen with the naked eye, and one 36 inches in diameter collects 32,000 times more light than an eye would perceive, and concentrates it into a luminous image. The part played by the objective, then, is to increase the apparent brightness of the objects observed. On this account, it is possible to see the brighter stars in the day-time, with a telescope of moderate dimensions; for though the few rays of light that enter the pupil of the eye from such stars are insufficient to excite the visual sense, the large number of rays collected by the lens, and concentrated into a beam small enough to enter the pupil, is sufficient to do so. The larger the lens, the larger is the amount of light collected by it. In fact, the power of a telescope—taking this expression to mean the ability of the instrument to reveal faint objects—is measured by the diameter of the objective. The cry of the astronomer is 'More Light,' and optical glass manufacturers have been taxed to the utmost to satisfy his cravings.

But, it will be asked, what about the ability of the telescope to magnify the heavenly bodies, to bring the denizens of space apparently nearer to us? This power is obtained by means of the combination of lenses at the eye end of the telescope, and can be varied



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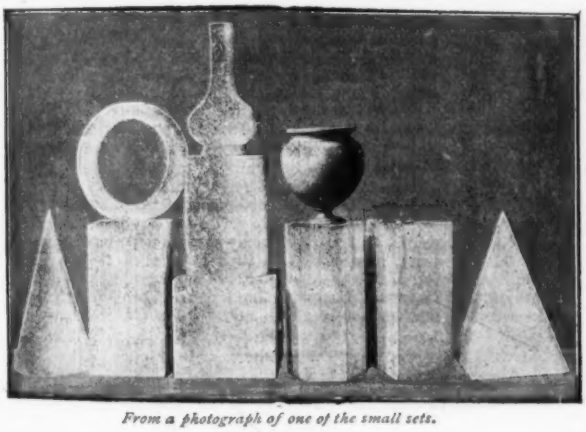

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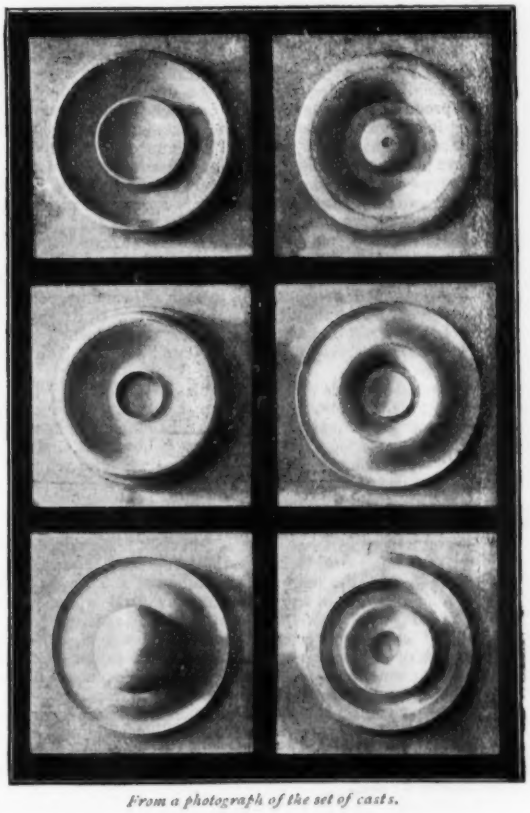

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at will. A telescope of any pretensions has a stock of such lenses belonging to it, capable of magnifying from 50 to about 1,000 times. For many observations in astronomy, a high magnifying power is undesirable, and in some cases useless. This comes as a shock to the ideas of most visitors to observatories. They expect to see stars appear at least as big as saucers, and can hardly realise that it is impossible to magnify these distant bodies. A star is never seen otherwise than as a point of light, when viewed under proper conditions. It is more or less brilliant according to the size of the telescope, but possesses no particular features. The number of stars, however, that can be seen by telescopic aid is enormous. To the naked eye, on a very fine night, about 2,500 stars are visible. By using a common opera-glass, this number is increased to 100,000, and a telescope two-and-a-half inches in diameter will show three times as many. But, though it is impossible to magnify the stars, yet the sun, moon, and planets—objects much nearer to us—can have their apparent size increased. An instrument of moderate dimensions will show the moon as it would be seen by the naked eye at a distance of about 500 miles, and any streak or wall upon the lunar surface a quarter of a mile or so long can then be easily distinguished. During the opposition of Mars this year, the planet passed the earth on October 12 at a distance of about 40,000,000 miles. If it had been possible to use a power magnifying one thousand times when observing our ruddy brother, he would have appeared one thousand times nearer to us, that is, at a distance of 40,000 miles. But according to reports received up to now, this high magnification was not achieved, for in no telescope could Mars be apparently brought nearer than about 70,000 miles.

The largest telescope in the world in which a glass lens is used to condense the beams of light is at the Lick Observatory, Mount Hamilton, California. The diameter of the objective is 36 inches, and the length of the telescope 60 feet. This telescope will show a hundred million stars to an ordinary observer—that is, a star each for every English-speaking person in the world. The image of the moon produced by the large lens is five inches in diameter; and by letting it fall upon a prepared plate, some marvellous photographs of our satellite have been taken. From an examination of the best of these pictures, it has been found that parallel walls on the moon, whose tops are not more than 200 yards or so in width, and which are not more than 1,000 or 1,200 yards apart, are plainly visible. The second largest refracting telescope has a lens 30 inches in diameter. It is erected at Pulkova, Russia. There is one slightly smaller than this at Nice. The next in size is the Vienna telescope, diameter 27 inches. After these come three instruments of about 26 inches, one at Greenwich Observatory, another in Washington, and the third belonging to Virginia University. Then follows the refractor, having a diameter of 25 inches, presented two or three years ago by Mr. Newall to the University of Cambridge.

It is doubtful whether telescopes with glass objectives will be made much larger than those now in use. Considerable difficulties are experienced in the manufacture of the discs of clear glass required for the lenses. After several years spent in unsuccessful attempts, a firm of glass makers has managed to cast the disc required for a lens of 40 inches diameter, but some time must elapse before the telescope for which it is intended will be in working order.

Besides the familiar form of telescope, there is another kind known as reflecting telescopes, or reflectors. In this, a concave mirror, shaped like the mirror sometimes placed behind gaslights, takes the place of the large lens. And since it is much easier to make a large mirror than to cast a disc of glass without blemish, we find that the largest telescopes in the world are reflectors. The renowned instrument erected for Lord Rosse at Parsonstown, Ireland, is of the same length as the Lick telescope—sixty feet—and has a diameter of six feet, so that the tube could be walked through by a tall man without the necessity of stooping. The next in size is a magnificent five-foot instrument constructed and possessed by Mr. A. A. Common, of Ealing. Sir William Herschel built a reflector four feet in diameter a little more than a century ago; another of the same size was erected by Mr. Lassell in 1860, and one at Melbourne in 1870.

So much has recently been written about communicating with the moon and some of the planets, that a remark made by Mr. Lassell concerning the efficiency of his telescope should be interesting. He claimed that if the lunarians were shaking a carpet as large as Lincoln's Inn Fields, he could see whether it was round or square. As Professor Norman Lockyer has said, 'This would be the *ne plus ultra* in the case of a body at the distance of the moon, viz. 240,000 miles.'

There are in England several reflecting telescopes about three feet in diameter—that is, of the same size as the Lick Observatory refractor. Mr. Common has one at Ealing, in addition to his five-foot instrument, and Professor Lockyer has another of excellent quality at South Kensington.

It is well known that the heavenly bodies are constantly in motion across the sky; hence, to observe them telescopically, it is necessary that the instrument should be made to move at the same rate. This desideratum is realised in all telescopes of importance. An astronomer first points his telescope to the object he wishes to observe, and then connects it with a clockwork arrangement which will drive it at the same rate as the stars. Should the sky afterwards cloud over, the telescope can be left to itself for a time, but when it is clear again the astronomer goes back, and is able to continue his work without any readjustments, for the object will still be in the field of vision.

In this connection a few words on the way in which stars are photographed may not be out of place. When a photographer is taking a portrait he generally says, before taking the cap off the lens, 'Keep still, please.' But the heavenly bodies do not obey the will of the astronomer in their movements, and the difficulty is got over by the driving-clock making the telescope follow the stars. Another difficulty in celestial photography is the extreme faintness of many of the objects whose impressions are required. In taking a portrait it is usually sufficient to keep the cap off the lens of the camera, so as to expose the sitter to the prepared plate, for about a second. In astronomy, exposures of four, eight, or even twenty hours are often necessary. The operations are briefly as follows: First, the telescope is adjusted in its proper position, and a photographic plate is inserted in the place of the defective human eye—for, viewed as an optical instrument, the eye is full of imperfections. The astronomer can then sit down and indulge in a contemplative pipe as long as he likes. His telescope will do the work. The clock keeps the instrument directed towards the required region of the sky, and that region is leaving its imprint upon the photographic plate. If an exposure lasting throughout the night is not long enough, the slide of the camera is shut up at daylight, and opened again when the telescope has been given its proper direction on the following evening. As an example of the kind of assistance given by photography to astronomy, it may be remarked that 16,000 stars have been photographed in an area of the sky in which only 94 stars could be seen with a 3-inch telescope, and less than half-a-dozen could be distinguished with the naked eye. The reasons for this are that the photographic plate is sensitive to rays which produce no visual effect; and that it can accumulate luminous impressions which in the case of the human retina fade entirely away every tenth of a second. Hence it is possible to photograph objects so faint as to be altogether beyond the power of any telescope to reveal to any observer. In this direction, therefore, will the astronomy of the future be developed, for telescopes may almost be said to have reached their greatest size. And even if this were not so, the photographic plate does away with the necessity of constructing larger and consequently more cumbersome instruments than those now in use.

SOLUTIONS TO QUESTIONS IN THEORETICAL MECHANICS.

BY F. CASTLE, M.I.M.E.

(*Continued from p.* 14, *October Supplement.*)

10. (*a*) State the meaning of the formula $v^2 = V^2 + 2fs$, and of each letter in it.

(final velocity)^2 = (initial velocity)^2 + 2 (acceleration × space).

In the given formula v represents final velocity in feet per second.

V represents initial velocity in feet per second.

f represents the acceleration of the particle in feet per sec., per sec.

s represents the space (in feet) described since the body had a velocity V.

In the formula the acceleration is assumed to be uniform.

(*b*) If a particle, whose mass is 15 lbs., moves along a straight line under the action of a force of 40 poundals, what will be the numerical value of f, and in what units is it expressed?

Using the formula $F = Mf$ (where F = force in poundals, M = mass in lbs., f = acceleration).

$$f = \tfrac{40}{15} = 2\tfrac{2}{3} \text{ feet per sec., per sec.}$$

(*c*) If that particle describes a distance of $33\frac{3}{4}$ ft., and has a velocity of 4 ft. a second at the beginning of the distance, what velocity will it have at the end?

From the above formula

$$v^2 = 4^2 + 2 \times \tfrac{8}{3} \times 33\tfrac{3}{4}$$
$$= 16 + 180 = 196;$$
$$\therefore v = 14 \text{ ft. per sec.}$$

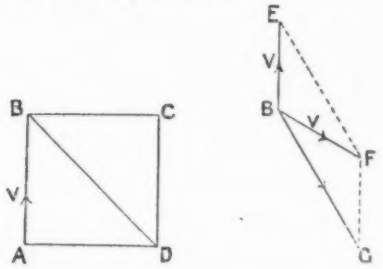
11. (*a*) State the rule for the composition of two velocities.

If a moving point possess simultaneously velocities represented in magnitude and direction by the two sides of a parallelogram drawn from a point, they are equivalent to the velocity represented in magnitude and direction by the diagonal of the parallelogram.

(*b*) Draw a square ABCD, and a diagonal BD; a particle moves along AB with a given velocity; find the velocity that must be impressed on it at B to make it move from B towards D with a velocity equal to that with which it was moving along AB.

Draw the square ABCD and the diagonal BD.

Take any point B^1, and draw B^1E equal to the velocity acting along AB, and parallel to AB. Draw a line B^1F equal to B^1E and parallel to BD; join F to E, and draw B^1G parallel to EF, and FG parallel to B^1E; then B^1G is velocity required.



12. (*a*) A body, whose mass is 10 lbs., is carried up to the top of a house 30 ft. high; by how many foot-poundals has the change of position increased its potential energy?

Increase of potential energy $= 10 \times 32 \times 30 = 9{,}600$ foot-poundals.

(*b*) If it is allowed to fall, what number of foot-poundals of kinetic energy will it have when it reaches the ground? ($g = 32$.)

When the body reaches the ground, the whole of the potential energy will be changed into kinetic energy.

$\therefore$ kinetic energy when body reaches the ground $= 9{,}600$ foot-poundals.

(*c*) If the mass of a particle is 24 lbs., and its kinetic energy is 75 foot-poundals, what is its velocity?

$\frac{1}{2} \times 24 \times V^2 = 75$, where V = velocity of body;

$\therefore V^2 = \frac{75}{12} = \frac{25}{4}$;

$\therefore V = 2\frac{1}{2}$ ft. per sec.

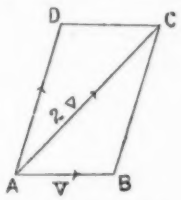
(*d*) Define a foot-poundal.

A foot-poundal is the work done by a force of one poundal (about half an ounce) acting through a distance of one foot, the distance being measured in the direction in which the force acts.

SOLIDS.—Advanced Stage.

21. (*a*) State the rule for the composition of two velocities.

See answer to Question 11, Elementary Stage.



(*b*) Draw two lines AB, AC, containing an acute angle; a particle is at A, moving with a given velocity V from A towards B; give a construction for determining the velocity that must be impressed on it to make it move with a velocity 2V from A towards C.

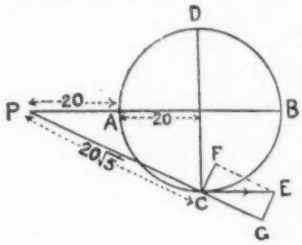
Make $AC = 2AB = 2V$, join CB, and draw through A a line AD parallel to CB, and through C draw a line CD parallel to AB, then AD represents the magnitude and direction of the velocity required.

22. (*a*) Draw a circle with centre O, and two diameters AB, CD, at right angles to each other, and let the direction A, C, B, be contrary to that of the motion of the hands of a watch; produce OA to P, making AP equal to OA; let the radius of the circle be 20 ft.; suppose a particle to move along the circumference of the circle in the direction A, C, B, at the rate of 12 ft. a second; find its angular velocity with respect to O.

Let v = velocity of particle in ft. per sec.

„ r = radius of circle in ft.

„ w = angular velocity.



From $v = wr$.

$\therefore 12 = w \times 20$.

$\therefore w = \frac{12}{20} = \frac{3}{5}$.

(*b*) Find also its angular velocity with respect to P, (1) when it is at A, (2) when it is at C, (3) when it is at B.

(1) $w = -\frac{12}{40} = -\frac{3}{5}$.

(2) For the point C, resolve the given velocity along the radius (PC) and perpendicular to it (the component CG will give no angular velocity). Divide velocity along CF by the radius PC, and we then obtain the angular velocity about P required, thus—

$$\text{Velocity along CF} = \text{CE} \cos \text{FCE}.$$
$$= \text{CE} \sin \text{CPO}.$$
$$= 12 \times \frac{20}{20\sqrt{5}} = \frac{12}{\sqrt{5}}$$

$$\therefore \text{angular velocity when at C} = \frac{12}{\sqrt{5} \times 20\sqrt{5}}$$
$$= \frac{3}{25}.$$

(3) Angular velocity when at B $= \frac{12}{60} = \frac{3}{15}$.

23. (*a*) State Newton's Three Laws of Motion.

First Law: Every body continues in a state of rest or of uniform motion in a straight line, except in so far as it may be compelled to change that state by force acting on it.

Second Law: Change of motion is proportional to the acting force, and takes place in the direction of the straight line in which the force acts.

Third Law: To every action there is always an equal and contrary reaction; or the mutual actions of any two bodies are always equal and oppositely directed in the same straight line.

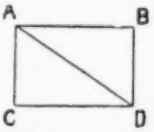
(*b*) Give his illustrations of the Third Law of Motion.

(1) If any one presses a stone with his finger, his finger is also pressed by the stone.

(2) If a horse draws a stone fastened to a rope, the horse is drawn backwards, so to speak, equally towards the stone.

(3) If one body impinges on another and changes the motion of the other body, its own motion experiences an equal change in the opposite direction.

(*c*) Give Newton's Proof of the Parallelogram of Forces.



Suppose that a force M, impressed separately on a body when at the point A, would cause it to move in a given time from A to B with a uniform velocity; and suppose that a force N, impressed separately on the same body when at the point A, would cause it to move in the same time from A to C with a uniform velocity. Let the parallelogram ABDC be completed. Then, if the forces are supposed to be impressed simultaneously, the body will move in the same time with a uniform velocity from A to D. For since the force N acts along AC parallel to BD, this force by the second law will not change the velocity of approach to BD, generated by the other force. Therefore the body approaches the line BD in the same time, whether the force N be impressed or not; and at the end of the given time it will be found somewhere in BD. In the same way it can

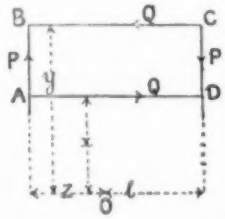
be proved that at the end of the same time it will be found somewhere in the line CD; and therefore it must be found at their point of intersection D. But by the first law it will proceed by a rectilinear motion from A to D.

Now bearing in mind that forces impressed instantaneously on equal masses are proportional to the velocities they generate, it follows that the forces M, N, and their resultant are proportional to the lines AB, AC, and AD.

24. (*a*) Define a couple.

A couple consists of two equal unlike parallel forces, not in the same line of action.

(*b*) Let A, B, C, D be the angular points of a rectangle taken in order; let equal forces (P) act from A to B and C to D respectively; also let equal forces (Q) act from A to D and C to B respectively; without assuming any property of couples, show that when the four forces are in equilibrium P : Q :: AB : AD.



Take any point O, in the plane containing the forces, and draw perpendiculars from O to the lines of action of the forces. Let the lengths of these perpendiculars be x, y, z, and l, as shown in diagram.

Then for equilibrium we have $-Qx + Qy - Pz - Pl = 0$;

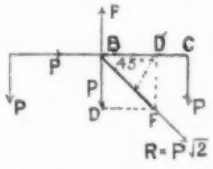
$$\text{or } Q(y - x) = P(z + l).$$

But $y - x = AB$ and $z + l = AD$;

$$\therefore Q \times AB = P \times AD;$$

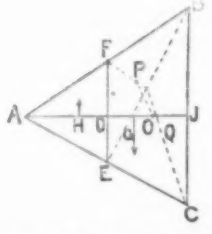
$$\text{or } P : Q :: AB : AD.$$

(*c*) Let A, B, C be three points in a straight line, B being midway between A and C; let three equal forces (P) act at A, B, C respectively at right angles to AC, viz., those at A and C in one direction, that at B in the opposite direction; let a fourth force, equal to P, act from A to C; find, in any way, the resultant of the four forces, and give the specification of the resultant when you have found it. (25)



The resultant of the two downward forces each equal to P, acting at A and C, is 2P acting at B; hence at B we have 2P acting along BD; also in the same line P upwards and P horizontal; hence making $BD' = BD = P$ the resultant is represented in direction and magnitude by the line BF, where $BF = P\sqrt{2}$, at an angle of 45° to AC as shown.

25. ABC is a triangle, and E, F the middle points of CA and AB; join EF; a particle, whose mass is 10, is placed at B; find the masses of the particles that must be placed at C, E, F if the centre of gravity of the four is to coincide with that of the area BCEF. (20)



The centre of gravity of the area BCEF can be obtained by construction as follows:—Bisect the base BC at J; join EB and AJ; bisect EB at K; the centre of gravity of triangle BFE is at P, where $KP = \frac{1}{3}KF$. Similarly Q is taken so that $KQ = \frac{1}{3}KC$; join PQ; the intersection of line PQ with AJ at O gives the centre of gravity of area BCEF. Or, take $JG = \frac{1}{3}JA$, then G is centre of gravity of triangle ABC.

Similarly $DH = \frac{1}{3}DA$ gives H the centre of gravity of triangle AFE.

Triangle AFE is similar to triangle ABC, and $AF = \frac{1}{2}AB$.

$\therefore$ area of triangle AFE $= \frac{1}{4}$ area of triangle ABC; also $AH = HG = GJ$.

Let $AJ = x$ and $GO = y$. Taking moments about O we have $\frac{1}{4}(HG + GO) = 1 \times GO$.

$$\therefore \tfrac{1}{4}(\tfrac{1}{3}x + y) = y.$$

$$\therefore \tfrac{3}{4}y = \tfrac{1}{12}x, \text{ or, } y = \tfrac{1}{9}x.$$

If the mass acting at C = 10, resultant of 10 at B and 10 at C = 20 at J.

If the masses at F and E be each equal to m, the resultant will be $2m$ at D.

$$\therefore 2m \times DO = 20 \times OJ.$$

$$\therefore 2m \times \left(\frac{x}{2} - \tfrac{8}{9}x\right) = 20\left(\frac{x}{3} - \frac{x}{9}\right).$$

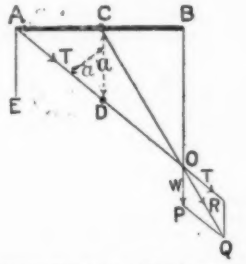
$$\therefore 2m \times \tfrac{5}{18}x = 20 \times \tfrac{8}{9}x.$$

$$\therefore m = 8.$$

Hence the masses are 10 at C, and 8 at E and F.

26. (*a*) AB is a rod without weight that can turn freely round a fixed point C, midway between A and B; a string is fastened to A and to a fixed point D, at a given distance vertically below C; a given weight is hung from B; the length of the string is such that AB is horizontal; find the tension of the string, and the magnitude and direction of the pressure on the fixed point C.

Let the given distance $CD = a$, W = the given weight, α = angle CDA = inclination of string to the vertical, and T = tension in the string AD.



Draw AE perpendicular to AB, then component of T in line AE multiplied by length AC must equal W × BC.

$\therefore T \times \cos\alpha \times AC = W \times CB$; but $AC = CB$;

$$\therefore T \cos\alpha = W.$$

Produce AD and line of action of W to meet at O; join OC; then OC is the direction of the reaction at fixed point C, and CO is direction of pressure on C.

Complete the parallelogram at point O, then OQ = R = resultant, or, $\therefore$ pressure on C. The length OQ can be measured, or,

$$R = W^2 + T^2 - 2WT\cos OPQ$$
$$= W^2 + T^2 + 2WT\cos\alpha$$
$$= 3W^2 + T^2.$$

(*b*) If the rod were simply placed on a smooth fixed point at C, would it stay at rest? And if not, why not? (25)

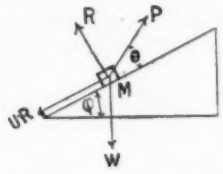
If C was a smooth fixed point the rod would not stay at rest, because the smooth point could offer no resistance to the revolved part of T along the rod, which would therefore cause the rod to slide in a direction AB.

27. (*a*) A particle of given weight is placed on a rough inclined plane; find the relation between the power and the weight, when the power is on the point of making the particle slide up the plane.

Let the particle M of given weight W be acted on by the force P, making an angle θ, with the plane.

Let μ denote the coefficient of friction; R the normal reaction of the plane.

Revolving along the plane we have $W \sin \phi + \mu R = P \cos \theta$. (1)



Revolving perpendicular along the plane we have $R - W \cos \phi = -P \sin \theta$. (2)

Eliminating R, $\therefore W(\sin \phi + \mu \cos \phi) = P(\cos \theta + \mu \sin \theta)$.

$$\therefore \frac{P}{W} = \frac{\sin \phi + \mu \cos \phi}{\cos \theta + \mu \sin \theta}.$$

(*b*) A particle will just stay at rest on a plane inclined at an angle of 30° to the horizon; if the angle of the plane is reduced to 15°, compare the force acting parallel to the plane that will just make the particle slide down the plane, with the force acting parallel to the plane that will just make the particle slide up the plane. (25)

If angle of repose be 30°, then $\mu = \tan 30° = \frac{1}{\sqrt{3}}$.

Also, since P acts parallel to the plane $\theta = 0°$, $\therefore \cos \theta = 1$, $\sin \theta = 0$.

Hence force required to make the particle slide up is $P = W(\mu \cos \phi + \sin \phi)$.

Hence force required to make the particle slide down is $P' = W(\mu \cos \phi - \sin \phi)$.

$$\therefore \frac{P'}{P} = \frac{\mu \cos \phi - \sin \phi}{\mu \cos \phi + \sin \phi}.$$

$$\sin 15° = \frac{\sqrt{3} - 1}{2\sqrt{2}}.$$

$$\cos 15° = \frac{\sqrt{3} + 1}{2\sqrt{2}}.$$

$$\therefore \frac{P'}{P} = \frac{\frac{1}{\sqrt{3}} \times \frac{\sqrt{3}+1}{2\sqrt{2}} - \frac{\sqrt{3}-1}{2\sqrt{2}}}{\frac{1}{\sqrt{3}} \times \frac{\sqrt{3}+1}{2\sqrt{2}} + \frac{\sqrt{3}-1}{2\sqrt{2}}}.$$

$$= \frac{\sqrt{3}+1-3+\sqrt{3}}{\sqrt{3}+1+3-\sqrt{3}} = \frac{\sqrt{3}-1}{2} = \frac{\cdot 732\ldots}{2}.$$

28. (*a*) Define a poundal.

When a pound, a foot, and a second are respectively the units of mass, length, and time, the corresponding unit of force is called a poundal, and this force acting on unit mass produces unit momentum in one second.

(*b*) It is known that the acceleration due to the attraction of a planet on a body near its surface varies nearly as the mass of the planet directly, and the square of its radius inversely. It is found that the mass of Jupiter is about 370 times that of the earth, and that his radius is about 11 times that of the earth. With these data, and assuming that the acceleration due to gravity near the earth's surface is 32 in feet and seconds, find the force in poundals of Jupiter's attraction on a pound of matter near his surface. (25)

Acceleration near the surface of Jupiter

$$= \frac{370}{1} \times \frac{1}{121} \times 32$$

$$= 97{\cdot}85.$$

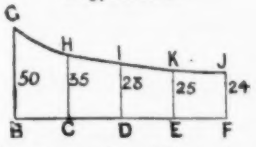
Hence the attraction on 1 lb. of matter near the surface of Jupiter = 97·85 poundals nearly.

29. (*a*) Draw a line Ax, and take in it five equidistant points B, C, D, E, F; suppose a force (P) to act along Ax, and that its values at the points B, C, D, E, F are respectively 50, 35, 28, 25, 24 lbs.; let the distances BC, CD, . . . represent 3 ft. a piece; draw a diagram of the work done by the force, and calculate (by Simpson's Rule, if you know it) in foot-pounds the work done by the force while acting from B to F.

Diagram of work done by the force is represented by the area BFJG, *Simpson's Rule.* Add together the first and last ordinates, twice the sum of all the other odd ordinates, and four times the sum of all the even ordinates, and multiply the result by one-third of the common distance between two adjacent ordinates.

$\therefore$ Work done $= \{50 + 24 + 2(28) + 4(35 + 25)\} \times \frac{1}{3} \times 3$

$= 370$ foot lbs.



(*b*) Find also what the result would have been, if no more than the values of P at B, D, F had been given. (25)

If only the values at B, D, F were given,

Work done $= \{50 + 24 + 4 \times 28\} \times \frac{1}{3} \times 3$

$= 186$ foot lbs.

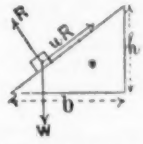
Note.—When Simpson's Rule is used care should be taken that the number of ordinates is odd (viz., 5, 7, 9, &c.), and the distances between them are equal.

In (*b*) instead of using Simpson's Rule the result would be better as follows:—

$$\text{Work done} = \frac{50 + 28}{2} \times 6 + \frac{28 + 24}{2} \times 6$$

$$= 78 \times 3 + 52 \times 3 = \underline{390 \text{ ft. lbs.}}$$

30. (*a*) A particle slides down a rough inclined plane; find the acceleration of its velocity.



Let l, h, and b denote the length, height, and base of the plane respectively, then force causing acceleration

$$= \frac{Wh}{l} - \frac{uWb}{l}$$

$$= \frac{W}{l}\left(h - ub\right)$$

But force = Mass × acceleration, or $F = Mf$.

$$\therefore f = \frac{F}{M} = \frac{W}{l}\left(\frac{h - ub}{W}\right) \times g$$

$$= \frac{h - ub}{l} \times g \text{ ft. per sec. per sec.}$$

(*b*) The angle of inclination of the plane is 30°; and the coefficient of friction is 0·5; if one body falls freely through a given distance, and another body slides down the plane along an equal distance, show that the time of the first body's motion will very nearly equal one fourth part of the time of the second body's motion. ($\sqrt{3} = 1{\cdot}73205$.) (20)

When the particle falls freely $t = \sqrt{\frac{2s}{g}}$

,, ,, moves along incline, $t' = \sqrt{\frac{2s}{f}}$

$$\therefore \frac{t}{t'} = \frac{\sqrt{\frac{2s}{g}}}{\sqrt{\frac{2s}{f}}} = \frac{\sqrt{f}}{\sqrt{g}}$$

$$= \frac{\sqrt{(h - ub)g}}{\sqrt{l} \times \sqrt{g}} = \frac{\sqrt{\left(1 - \frac{\sqrt{3}}{2}\right)}}{\sqrt{2}} = \frac{\sqrt{(2 - \sqrt{3}}}{2}$$

$$= \frac{\sqrt{\cdot 26795}}{2} = \frac{1}{4} \text{ nearly.}$$

31. (*a*) A body is tied to a string and is whirled round in a vertical circle; find the least velocity it can have at the lowest point, if it is to describe the whole circle.

When the body is in the lowest position it must have sufficient kinetic energy to carry it to a height equal to twice the radius of the circle.

Hence $\frac{WV^2}{2g} = W \times h = W \times 2r$;

$\therefore V^2 = \frac{W \times 2r}{W} \times 2g$,

$V = 2\sqrt{rg}$,

where g = acceleration due to gravity,
" r = radius of circle in feet,
" V = velocity in ft. per sec.,
" W = weight of body in lbs.

(*b*) If the mass of the body is 12 lbs. and the length of the string 6 ft.; find the tension of the string at the lowest point if the body just stays in the circle ($g = 32$).

$$F = \frac{WV^2}{gr} = \frac{12 \times 4 \times r \times g}{g \times r}$$
$$= 48 \text{ lbs.}$$

$\therefore$ centrifugal force = 48 lbs.
and weight of body = 12 lbs.
$\therefore$ Total pull on centre = tension in string,
$= 48 + 12 = 60$ lbs.

(*c*) In what units is your answer expressed? (25)
In gravitation units.

32. (*a*) A is a particle at rest, and B moving with a given velocity impinges on it directly; find from first principles the coefficient of restitution if B is brought to rest by the collision.

Let the masses of A and B be M′ and M respectively, and their velocities before impact V′ and V. After impact let the velocity of A be denoted by V″. Then relative velocity before impact = V, since V′ is = 0.

$\therefore MV = M'V''$,

$\therefore V'' = \frac{MV}{M'}$; (1)

$\therefore$ coefficient of restitution $= \frac{\text{relative velocity after impact}}{\text{" " before "}}$

$= \frac{V''}{V} = \frac{M}{M'}$

(*b*) The masses of A and B are 12 lbs and 4 lbs. respectively, and B's velocity is 10 ft. a second; find how many foot-poundals of kinetic energy disappear in the collision, if B is brought to rest. (25)

Here M = 4; M′ = 12; V = 10.

From (1) we have $V'' = \frac{MV}{M'} = \frac{4 \times 10}{12} = \frac{10}{3}$.

Energy before impact $= \frac{1}{2}MV^2 = \frac{1}{2} \times 4 \times 100$
$= \underline{200 \text{ foot poundals.}}$

Energy after impact $= \frac{1}{2}M'(V'')^2$
$= \frac{1}{2} \times 12 \times \frac{100}{9}$
$= \frac{200}{3}$ foot poundals.

$\therefore$ Difference in energy $= \left\{\begin{matrix}\text{No. of foot-poundals of kinetic energy which disappear in the collison}\end{matrix}\right\} = 200 - \frac{200}{3} = 133\frac{1}{3}$.

FLUIDS.

Elementary Stage.

1. (*a*) Define the resultant of two forces.

If a single force can be found whose effect upon the body is the same as that of the given forces, this single force is called the resultant of the other two forces.

(*b*) Three forces act along parallel lines; two are forces of 5 and 7 units acting from right to left, the third is a force of 15 units acting from left to right; what is the magnitude of their resultant, and in what direction does it act? Do the terms of the question enable you to say along what line the resultant acts? Give a reason for your answer. (12)

The magnitude of the resultant is $15 - 12 = 3$, in the same direction as the force of 15 (from left to right). In order to determine the line of action of the resultant, we require the perpendicular distance between the lines of action of the given forces, and also the distribution of the forces. Hence we can only give the direction and magnitude of the resultant from the data given.

2. The specific gravity of gold being 19·2, and that of lead being 11·2, find the ratio which the quantity of matter in 5 cubic inches of lead bears to the quantity of matter in 7 cubic inches of gold. (12)

Let w denote the weight of a cubic inch of water.

Then weight of 7 cubic inches of gold $= 19{\cdot}2 \times 7 \times w$,
and " 5 " lead $= 11{\cdot}2 \times 5 \times w$;

$\therefore \frac{\text{Quantity of matter in piece of lead}}{\text{" " " gold}} = \frac{11{\cdot}2 \times 5 \times w}{19{\cdot}2 \times 7 \times w}$

$= \underline{\frac{5}{12}}$.

3. (*a*) A particle moves along a straight line and its velocity is uniformly accelerated; at a certain instant it was moving at the rate of 800 yards a minute, and after 6 seconds it is moving at the rate of 55 ft. a second; what is the acceleration in feet and seconds?

800 yards per min. $= \frac{800 \times 3}{60} = 40$ ft. per sec.

Increase of velocity in 6 seconds $= 55 - 40 = 15$ ft. per sec.

$\therefore$ Acceleration $= \frac{15}{6} = \underline{2\frac{1}{2} \text{ ft. per sec. per sec.}}$

(*b*) If the mass of the particle is 12 ozs., how many poundals are there in the force to which the acceleration is due? (14)

Force = Mass in lbs. $\times$ acceleration
$= \frac{12}{16} \times \frac{5}{2}$
$= \underline{1\frac{7}{8} \text{ poundals.}}$

4. Given the equation of work and energy for a particle, viz.:— $\frac{1}{2}mv^2 - \frac{1}{2}mV^2 = Ps$, state the meaning of each letter in the equation.

A particle, whose mass is 12 lbs., has its velocity changed from 5 ft. a second to 11 ft. a second; what number of foot poundals of work has been done by the force to which the change is due? (12)

P = force in poundals (assumed to be constant),
S = distance in feet through which P acts,
M = mass in pounds,
V = velocity in ft. per sec. when P begins to act,
v = " " after P has acted through a space s,
and the equation $\frac{1}{2}mv^2 - \frac{1}{2}mV^2 = Ps$ means *change of kinetic energy = work done.*

If the force P is of the nature of a resistance and *opposes* the the body's motion, the equation is still true, only V will then be greater than v, *negative* work being done by the force P.

$$\text{Work done} = \frac{12}{2} + 11^2 - \frac{12}{2} \times 5^2$$
$$= 6(11^2 - 5^2) = 6 \times 96$$
$$= \underline{576 \text{ foot poundals.}}$$

5. State how the pressure at any point of a fluid is measured.

P is a point 10 ft. below the surface of a liquid, one cubic inch of which weighs one-thirtieth of a pound; two men, *A* and *B*, are talking about the pressure at P; *A* says it is 4 lbs.; *B* says it is 576 lbs.; the difference is simply due to neither of them saying exactly what he means. Show this by completing their statements. (14)

The intensity of pressure at any point of a fluid is equal to the weight of a right prism of the fluid, whose base is unit area and whose height is equal to the depth of the point below the surface of the fluid.

Pressure per square inch at P $= 10 \times 12 \times 1 \times \frac{1}{30} = 4$ lbs.
" " " foot " $= 10 \times 12 \times 1 \times \frac{1}{30} \times 144$
$= 576$ lbs.

Thus *A* refers to the question per sq. in., and *B* to the pressure per sq. ft.

6. (*a*) When a body is partly immersed in a liquid, along what line does the resultant of the fluid pressures act?

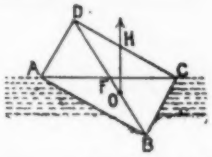
The resultant acts vertically upwards, is equal to the weight of the liquid displaced, and acts through the centre of gravity of the displaced liquid.

(*b*) ABCD is a rectangular lamina; it is held in a vertical plane with the diagonal AC on the surface of water; show in the diagram the line along which the resultant of the fluid pressures acts.

If AB, BC are 10 ft. and 4 ft. long respectively, and if the thickness of the lamina is 1 inch, find the magnitude of the resultant pressure. (N.B.—A cubic foot of water weighs 1,000 oz.)

Let ABCD be the given rectangular lamina. AC on the surface of the water. Join BD, cutting AC at F. Make

FO = $\frac{1}{3}$ FB, then O is the centre of gravity of the liquid displaced, and the vertical line OH is the line of action of the resultant liquid pressure.



Resultant pressure = volume in cubic ft. of triangle (ABC) × 1,000 ozs.

$$= \frac{10 \times 4}{2} \times \frac{1}{12} \times 1000$$

$$= \underline{1,666\tfrac{2}{3} \text{ ozs.}}$$

7. A ball of beech-wood (sp. gr. 0·7) weighs 3 lbs.; it is fastened by a thread to the bottom of a barrel; the length of the thread and the diameter of the ball are together less than the height of the barrel; if the barrel be filled with water, what position will the ball take and what will be the tension of the thread? (14)

The resultant pressure will pass through the centre of the sphere and be vertical. Hence the string will be vertical and the ball in its highest position.

Weight of ball = 3 lbs.

,, ,, an equal volume of water = $\frac{10}{7} \times 3 = 4\frac{2}{7}$ lbs.

∴ Tension of the thread = $4\frac{2}{7} - 3$

$= 1\frac{2}{7}$ lbs.

8. (*a*) Given the formula for the metacentre of a cyclinder floating with its axis vertical, viz., 4 HM. $hs = r^2$, state the meaning of the parts of the formula.

H denotes the centre of gravity of the liquid displaced, or centre of buoyancy (in the equilibrium position).

M ,, ,, metacentre.

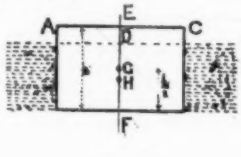
h ,, ,, total height of the cylinder.

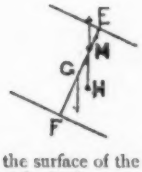
r ,, ,, radius of the cylinder.

s denotes the ratio of the specific gravity of cylinder to the specific gravity of the liquid.

Hence HM denotes the distance between the centre of gravity of liquid displaced (in the equilibrium position) and the metacentre.

(*b*) A cylinder (sp. gr. 0·7) has a radius of 7 in.; find the greatest height it can have, if it is to float with its axis vertical in still water. (N.B.—$\sqrt{42} = 6{\cdot}48$.) (16)





Let AC represent the surface of the water.

h = FE = height of cylinder.

H the centre of gravity of fluid displaced.

G the centre of gravity of cylinder.

Then FH = $\frac{1}{2}$FD = $\frac{1}{2} \times \frac{7}{10}h = \frac{7}{10}h$;

also HG = FG − FH = $\frac{h}{2} - \frac{7h}{20}$

$= \frac{3}{20}h$.

The equilibrium is stable (when axis of cylinder is vertical) if G lies below M, or ∴ if HM>HG.

$$4\text{HM} \times h \times \tfrac{7}{10} = r^2 = 49;$$

$$\therefore \text{HM} = \frac{49 \times 10}{4 \times 7 \times h} = \frac{35}{2h}$$

Hence, since HM is to be greater than HG.

$$\therefore \frac{35}{2h} > \frac{3h}{20}$$

$$\text{or } \therefore h^2 < \frac{25 \times 42}{9}$$

$$\therefore \text{if } h^2 < \frac{5 \times \sqrt{42}}{3}$$

∴ if h < 10·8 inches.

Hence the height of the cylinder cannot exceed 10·8 inches.

9. What are the freezing and boiling points of a thermometer? They are commonly called fixed points; how do they differ under ordinary circumstances in respect of being fixed points?

A temperature is 20° on Fahrenheit's scale; what is it called on the centigrade scale? and what if the temperature is reckoned from absolute zero? (12)

The freezing point of a thermometer denotes the temperature at which ice begins to melt, and is marked 32° on the Fahrenheit scale. The boiling point of a thermometer denotes the temperature at which water boils under the standard atmospheric pressure, and is marked 212° on the Fahrenheit scale.

The boiling point of a liquid depends on the pressure. Increase of the pressure causes a rise of the boiling point; but for a fixed pressure there is a fixed boiling point. The freezing point is not sensibly affected by small changes in the pressure, it being only at great alterations of pressure that the freezing point is altered. Thus the melting point of ice is lowered by about the seventy-fifth part of a degree Fahrenheit for every additional atmosphere of pressure.

Temperature on the centigrade scale

$$= (20 - 32)\tfrac{5}{9} = -6\tfrac{2}{3}°.$$

To find the absolute temperature on the centigrade scale add 273 to the ordinary temperature.

∴ Absolute temperature = $273 - 6\frac{2}{3} = 266\frac{1}{3}$.

10. In the formula for gases, viz., VP = RT, what is the meaning of the letter T? If the temperature of the gas were 0°C., what would be the numerical value of T? (12)

T is the absolute temperature of the gas.

When the temperature is $t°$, we have T = $t° + 273$.

∴ T, at 0°C, = 273°.

Hence, on the 'Absolute scale of temperature,' freezing point would be marked 273°, and boiling point would be marked 373°.

11. Assuming that the weight of 100 cubic inches of dry air is 31 grains when the pressure is that due to 30 in. of mercury and when the temperature is 14°C., find the weight of the air in a room 20 ft. long, 15 ft. wide, and 12 ft. high, the air being dry, the barometer standing at 30 in., and the temperature being 27°C. (16)

Volume of room = 20 × 12 × 15 × 1728 cubic inches.

$$\text{Volume of air at } 27°\text{C.} = \left(\frac{27 + 273}{14 + 273}\right) \times 100$$

$$= \frac{300}{287} \times 100$$

$$\therefore \text{Weight of air in the room} = \frac{20 \times 12 \times 15 \times 1728 \times 287}{300 \times 100} \times 31$$

$$= \underline{1,844,881{\cdot}92 \text{ grains.}}$$

(*To be continued.*)

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Wisdom is humble that he knows no more.'—COWPER.

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WELL-KNOWN TEACHERS AT WORK.

XXXV.—MR. GEORGE WEST,

Head Master Beechwood School, Markyate Street, Dunstable.

IF a successful career extending over a quarter of a century is a passport to a place among the 'Well-known Teachers at Work,' then, indeed, is the subject of this sketch entitled to the honour. Here we have no town school with all the advantages surrounding such, but a village school,

> Far from the sight of city spire, or sound
> Of minster clock!

Your request, Mr. Editor, that I should visit Mr. West, the man of whom H.M.I. to-day speaks as highly as did the Inspector of 1877, was readily met, for I had heard much of his success, and had seen for myself not a little of it while in the neighbourhood in the years gone by.

Beechwood can be approached from Hemel Hempstead, from St. Albans, from Luton, or from Dunstable. On the occasion of my visit I was favoured with delightful weather, so that my fairly long walk was most enjoyable. Reaching the school, which stands on a hill as you approach from Markyate Street, I made my presence known, and at once explained my mission. My victim was busily at work with a class of boys and girls (a reading lesson).

While this was going on I was free to take a look at the other classes. Some of the children were analysing sentences on slates; another division, in charge of a fine young fellow who I was afterwards surprised to learn was but a pupil teacher in his second year, was engaged in selecting the parts of speech from a reading book; the children in another division were endeavouring to excel in neatness and finish the copy-book headings before them; and away in another room I saw and heard the infants under the care of their mistress. By this time Mr. West was able to give me a minute or two, and (he had evidently been considering my request for an 'interview') he told me he had no objection to my seeing the school at work, but he thought there was no excuse for his appearance among 'THE PRACTICAL TEACHER'S' worthies. That was his modesty, of course, and I said so.

In a few minutes I had overcome all objections, so that, after a final protest, he submitted with as good a grace as possible. And now I had an opportunity of 'taking stock,' as it were, of this highly successful teacher. Of medium height, rather inclined to stoutness, with a beard in which the grey seemed to be striving for a respectable place, a happy face betokening contentment, with no suspicion of trouble—such, in brief, was the man who stood before me.

> A man he seems of cheerful yesterdays
> And confident to-morrows.

I was convinced in a moment that this happy disposition would account in no small degree for the condition of the school year after year. Mr. West returned to his class and resumed his lesson, I listening the while. It was the upper division, I found (Standards VI., VII., and ex-VII.), and the subject of the reading lesson was the United States.

The idea seemed afloat that I might be H.M.I. (he was expected shortly), and perhaps, for that reason, every one was doing his or her best. Anyhow, the reading was fluent, the style excellent, and the intelligence extremely satisfactory. A thoughtful question from the master, and many hands were up. Then there was some interesting item of information to supplement that in the book. And thus the lesson went on. I confess I was struck with the close attention of the pupils, the evident interest all round, the quiet, effective style of the master. It was one of the most interesting reading lessons I have ever heard. Mr. West's cheerful manner, the kind, sympathetic voice, commanded instant attention. I was forcibly reminded of what Elihu Burritt says: 'There is no power of love so hard to get and keep as a kind voice. . . . . A kind voice is to the heart what light is to the eye. It is a light that sings as well as shines.'

I passed round among the little ones who were writing. Here, too, was evidence of careful teaching.

Then I saw the grammar classes, and again it was not difficult to see that intelligent methods had been

employed. The analysing of the elder children was decidedly good, while the little ones in Standards II. and III. answered smartly and well the questions put by the pupil teacher referred to earlier in this paper. This young fellow was doing the work as thoroughly as even the most critical examiner could desire. His questions were carefully framed, his manner was pleasing, the interest of the children was secured.

I noticed that these young grammarians were not satisfied with simply naming the parts of speech. Encouraged by their teacher, they *parsed*.

We came to the word 'London,' for example. 'Noun proper, 3rd person, singular number,' said a bright little girl in the corner.

If a mistake were made, many hands were in the air, and I have no doubt Tom felt not a little chagrined when Mary corrected him. There was the keenest rivalry throughout the class. I passed on to the infants' room, where I spent a very pleasant and profitable quarter of an hour. Miss Bailey (the mistress) kindly put the little ones 'through their paces,' and action song followed action song. It was really amusing to see how hard even the youngest 'baby' tried to do as his fellows. The dear little people appeared as much delighted as I was. The mistress sang and the 'babies' drilled! There was a harmonium (and a good one) in the room, but it was used only for the chord. Miss Bailey sang the accompaniment. I am positive her little charges love her, for there was a smile on their faces all the time. No wonder the Inspector speaks highly of this department. Mr. West himself is full of praise for this bright and loving baby teacher.

It was with some amount of regret that I found the hour of dismissal at hand, and with many apologies for the interruption and my best thanks for the treat I had experienced, I returned to the main room.

'Here is a class about to take mental arithmetic,' said Mr. West; 'would you like to put a few questions?'

They were the seniors who had read to me earlier in the morning. 'This may be a challenge,' thought I; 'I will accept it'; and I plunged at once into the mysteries of decimal notation. With a blackboard to assist me, the class and I were soon at home. Starting with £1, we proceeded to £·1, £·2, £·25, £·5, £·75, and finding I was not on strange ground I again wrote £·25, then underneath £·125, £·0625, and £·03125, questioning at each stage. I did my best to discover weaknesses, but the attention was so keen, the training during the year had evidently been so thorough, that the most difficult tests found some ready reckoners!

I passed on to simple problems in interest and percentages generally, winding up with questions involving considerable calculations, but at every point there was the same intelligence, the same eagerness, the same desire to excel. It was impossible to resist a compliment.

Later on I met the lads at football on the green, and I could see they were anxious to convince me—if I would but join them—that while I might be, perhaps, a little in front of them in mental calculations, they could give me points in their favourite game! And I am certain they could!

From 12 to 12.30 I had Mr. West to myself, and sounded him on every subject that occurred to me. 'Come and see the premises,' said he. 'The Education Department called upon us for certain improvements in the building, and asked us if we were prepared to enlarge the infants' room. We have been able to meet their lordships on every point.' I saw for myself that the sanitary arrangements, and, indeed, every detail that made for comfort and health, had received the most careful attention, and I doubt if any school in the country could stand better in these respects. 'Your managers take a very proper view of these matters,' said I. 'Yes,' was the reply; 'I wish every teacher in the land could be so well placed. Our acting manager is Mr. Bennett, who lives near, and he takes a practical interest in everything that affects us. No better manager could be found.'

The buildings had been thoroughly overhauled, the drainage had been rendered practically perfect, the infants' room had been doubled in size. 'And really,' said Mr. West, 'there was no room for serious complaint before the improvements were effected, for our comfort and convenience have always been carefully studied.'

'And now,' said I, seeing a number of boys and girls in the yard, 'why are your scholars here so long after the close of morning school?' 'They remain for dinner,' he replied; 'the majority of them live so far away that it would be impossible for them to do otherwise.'

Then I discovered that a large number live a mile and two miles (some even at a greater distance) from the school. Mr. West is an extremely popular man, the farmers and others who know him all being anxious to place their children under his care. And with the name the school bears one cannot be surprised. Even little girls come long distances to secure the advantages offered.

'By the way,' I asked, 'do the girls take cookery?' 'Oh, yes,' said the enthusiast, 'they take drawing with the boys, and are taught cookery as well. You will have an opportunity of forming an opinion as to their powers directly, for some of them have been working this morning with Mrs. West, and our dinner is the result of their labours. They are trained in plain cooking, and when they leave us are able to prepare any ordinary dinner.' The opportunity soon came, and I have only to say I quite enjoyed the meal. The parents have reason to be satisfied when such training is brought within the reach of their children. Mrs. West is as enthusiastic as her husband, and her influence over the girls can only be for good. After the midday meal I resumed the *rôle* of questioner.

'What is the history of the school, Mr. West?' 'The school was originally founded and endowed by the great-grandfather of the present baronet, and from that time has been continuously at work. The present school and housewere built by Sir John Sebright, and they are the property of that family now,' he said. 'Sir John and Lady Sebright have ever been good friends to Beechwood, and though Sir John has passed away, Lady Sebright and her son, Sir Egbert, maintain all the old interest.' 'I have heard something of a present made to you some time ago, Mr. West; will you give me a few particulars?' 'There is no objection,' he replied; 'the good people here desired to recognize my work in their midst, and this is the result.' With this he brought under my notice a service of plate (solid silver, weighing 100 ounces). The case bore the inscription: 'Presented

BRITISH MUSEUM

to Mr. George West on completing 21 years' mastership of Beechwood School; by his friends, 1890.' 'Nothing has ever touched me so much,' he said; 'their kindness will be ever remembered by us.'

'Tell me something,' said I, leaving the subject, 'of your other work. You are an active member of the N.U.T., you helped to form the Luton Association many long years ago, you have been President of that Association two or three times, you have always been on the committee, you have attended several Conferences, and you are at the present moment one of the Parliamentary Correspondents for the Union. Is that not so?' Mr. West laughed. 'Yes; but where did you get the information?' I assured him that an interviewer is frequently compelled to obtain his facts as best he can, and we proceeded. 'Have you other claims upon your time?' 'Yes; I was for some time Chairman of the local Building Society, for many years Secretary of the Conservative Association (Markyate Street Branch of Mid Herts). I am agent for this polling district for the present member, Mr. Vicary Gibbs; Treasurer of the Flamstead Benefit Society, and Trustee of the Markyate Street Foresters' Society. In addition to this I am Secretary of the Technical Committee for Markyate Street and Flamstead. And that is not all, but it may be sufficient to prove that I have not many idle hours.' 'It is sufficient for me, at any rate,' I replied, and again the conversation was turned.

Faithfully Yours
G. West

'How do you account for your school success?' I asked. 'Ah, now you ask me a question I cannot answer, I fear; I can only say I love the work, and have always tried to do my best. Immediately one school year is ended we begin in earnest again; no time is lost. I think that is all I can say on that point. We believe in a good beginning.' Plato, more than two thousand years ago, declared that 'A beginning is half of all,' and Mr. West is apparently of the same opinion.

'What is your opinion of the Education Department's new requirements of suitable occupations? What will be the effect on country schools?'

'Such occupations for children are admirable,' he replied, 'but it will be next to impossible to carry them out under existing arrangements. We have quite sufficient to take up every minute of our time now, and if the new requirement is enforced, some other subject or subjects must suffer; of that I am convinced. We have taken algebra, for example, but that would go, and I don't think the ordinary subjects could possibly receive the attention they deserve. 'Is there anything else you can tell me as to your school?' I asked. 'Well, we have a library, a savings bank, and the beginning of a school museum. Mrs. West takes the needlework, and carries on that branch of the work to the complete satisfaction of H.M.I. In cookery, too, she has quite satisfied the Department, and although the grant is small, it is probably sufficient to cover the expenses. Let us join the boys at football, they look for me to be with them as often as possible.' In a moment we were on the green, and the master was as young as the youngest of his boys.

The game was thoroughly well played and keenly enjoyed. My old football days came back to me. For the moment I was young again, and I felt compelled to lead the forwards on one side in an attack on the goal. But the whistle blew, and my youth departed.

The afternoon was given up to drawing. The oldest boys were deep in the mysteries of solid geometry, others were drawing to scale, the remainder gave their attention to freehand. Once more I remarked that the work was extremely good, and that the examination results ought to be completely satisfactory. 'I am glad you think so,' Mr. West said; 'we have obtained the "Excellent," and hope to stand well again. You haven't seen the needlework yet. Mrs. West will show you some specimens, with pleasure.' Being a mere layman in such matters, I cannot pretend to know much of the needlework art, but what I saw seemed excellent.

'Do you find the needlework syllabus difficult for the girls?' I asked Mrs. West. 'It is fairly workable,' she replied. 'Cutting out is a most valuable accomplishment, and the girls like it. I give a good deal of attention to that branch, for I feel it is so important for these young people, looking to their future lives.'

I returned to the schoolroom and saw the apparatus, the maps, pictures, and many other things, particulars of which cannot be given here. Nothing seems wanting.

There was but one other duty. 'I have heard so much of your success, Mr. West, may I see what H.M.I. has to say?' 'With pleasure,' said he, and the Reports extending over many years were placed before me. 'One point I had forgotten,' he added:

'our attendance is remarkable. The Inspector was so much impressed with this some years ago that, at his request, I prepared a statement of the means employed to secure it, and this was published in the Blue Book as an Appendix to his Report. The parents are greatly interested in the school, and this you would see for yourself if you attended one of our annual concerts.'

I turned my attention to the Reports. They were practically all alike. I can only give a few selections:—

'It is always a great pleasure to visit this admirable school, which is specially valuable as showing the perfection to which attendance and attainments can be brought in a scattered rural district. The written work is very thorough and accurate, the oral answering exceedingly bright and intelligent, and the excellent discipline and influence cannot fail to be of real, permanent value to the children.'

'The discipline and tone are admirable, the teaching very sound and intelligent, and the work throughout exceptionally thorough and accurate; I have never been in a better school. The reading and repetition deserve special praise, but almost all subjects were excellent. The remarkably regular attendance is another testimony to the worth and influence of the school.'

'This is in every respect an excellent school, distinguished for sound and thorough teaching well diffused throughout the school, for thoroughness and accuracy in the written work, admirable tone and discipline, and exceptional intelligence in the oral examination. . . . It is to be noted that the attendance is very good indeed, that every child on the books was present on the day of inspection, etc., etc.

'This is in every respect an admirable school in every class, and in every branch of school work. The instruction is singularly sound, thorough, and intelligent, and the result was, if possible, even better than usual. The regularity of attendance is again remarkable. Singing by ear and sewing are very good.'

'The high character of the work in this school continues to be fully maintained, all the elementary work being remarkably well rendered, and the class and specific subjects showing the same careful and intelligent teaching.'

'This school maintains its exceedingly high reputation, all the subjects being thoroughly and well taught.'

'This school is supplied with a full staff, and is carried on with remarkable success. The attainments are very good throughout.'

But need more be quoted?

In the Blue Book for 1877 you will see the school placed among the *First Class*, and it has maintained its honourable position until now. If success is to be measured by Inspectors' Reports, then surely Mr. West has reason to be proud. These Reports, however, are not alone in their praises. With everyone he is the 'prince of good fellows,' and I am sure he deserves all that is said of him.

It was with regret that I began my preparations for departure. 'One word more,' said he. 'Two of my sons are in the profession. One took a 1st class scholarship and did well at St. Mark's College. The other is younger, but he has taken a 1st in the scholarship, too, and so he starts well.' I sincerely hope they will follow in their father's footsteps.

And now, the day being far spent, I thanked Mr. West for his courtesy, and Mrs. West for her kind and generous hospitality, and once more we reached the green.

> Ere long the sun declining shot
> A slant and mellow radiance, which began
> To fall upon us.

As I drove to the nearest railway station, making a few notes on the way, I could not help thinking that Beechwood was one of the brightest and one of the best schools it has ever been my privilege to enter.

'THE SQUIRE'S BIRTHDAY.'

A PLAY FOR BOYS.

BY JOSEPH DESPICHT,
Author of Prize Play, 'In 1999,' 'Should Men wear Hats?' etc.

CHARACTERS:—

SQUIRE HEARTY - - -	A country gentleman.
SMITHERS - - - -	His butler.
PRICE - - - - -	A detective.

'Sixth Form' Boys of Dr. Daymond's Grammar School *ad lib.*

Scene.—Squire Hearty's study—one window overlooking lawn.

Time.—A summer afternoon.

Discovered.—Smithers putting away papers, books, &c.

Smithers: Well, this is a fine piece o' work to set a man o' my years! Amuse twenty big boys for twenty minutes in a dry old study! The squire might as well have stuck me in a cage of monkeys in a 'Wombell's' menagerie, and told me to amuse them. The bald spot on my head is the size of

BEECHWOOD SCHOOL.—TIME TABLE.

Day.	MORNING.									AFTERNOON.					
	9—9.15.	9.15—9.40.	9.40—9.50.	Class.	Standard.	9.50—10.30.	10.30—10.45.	10.45—11.20.	11.20—12.	1.45—2.	Standard.	2—2.40.	2.40—3.20.	3.20—4.	
Monday.	Assemble and Prayers.	Religious Instruction.	Mark Registers.	1	VI.-VII.	Arithmetic	Recreation.	Reading	English	Assemble and Mark Registers.	VI.-VII.	History	Parsing	Recitn. or Comp.	Dismissal.
				2	V.	Arithmetic		Reading	English		V.	History	Parsing	Recitn. or Comp.	
					IV.	Arithmetic		Transcription	Reading		IV.	History	Parsing	Recitn. or Comp.	
				3	III.	Arithmetic		Geography	Copy Books		III.	History	English	Memory Writing	
				4	II.	Arithmetic		Geography	Copy Books		II.	Trans. or Dictn.	English	Reading	
				5	I.	Transcription		Arithmetic	Reading		I.	Trans. or Dictn.	Tables	Reading	
				1	Infants	Reading		Arithmetic	Transcription		Infants. 1	Object Lesson	Copy Books	Form or Colour	
				2	Infants	Writing		Reading	Mental Arithmetic		2	Object Lesson	Figures	Form or Colour	
				3	Infants	Figures		Writing	Reading		3	Object Lesson	Writing	Form or Colour	
Tuesday.				1	VI.-VII.	Arithmetic		Geography	Copy Books		VI.-VII.	Read. or Gram.	Special	Special	
				2	V.	Arithmetic		Geography	Copy Books		V.	Read. or Gram.	Special	Special	
					IV.	Arithmetic		Geography	Copy Books		IV.	Writing	Reading	Arithmetic	
				3	III.	Arithmetic		Reading	Transcription		III.	Writing	Reading	Arithmetic	
				4	II.	Arithmetic		Transcription	Reading		II.	Arithmetic	Writing	Reading	
				5	I.	Transcription		Arithmetic	Reading		I.	Arithmetic	Writing	Reading	
				1	Infants	Transcription		Reading	Mental Arithmetic		Infants. 1	Needlework	Needlework	Needlework	
				2	Infants	Reading		Transcription	Figures		2	Needlework	Needlework	Needlework	
				3	Infants	Figures		Writing	Reading		3	Needlework	Needlework	Needlework	
Wednesday.				1	VI.-VII.	Arithmetic		Composition	Comp. or Recitn.		VI.-VII.	Singing	Map Drawing	Map Drawing	
				2	V.	Arithmetic		Composition	Comp. or Recitn.		V.	Singing	Map Drawing	Map Drawing	
					IV.	Arithmetic		Dictation	Recitation		IV.	Singing	Map Drawing	Map Drawing	
				3	III.	Arithmetic		English	Copy Books		III.	Geography	Singing	Reading, History	
				4	II.	Arithmetic		English	Copy Books		II.	Geography	Singing	Memory Writing	
				5	I.	Geography		Arithmetic	Reading		I.	Transcription	Singing	Arithmetic	
				1	Infants	Tables		Reading	Arithmetic		Infants. 1	Tables	Drawing	Amusements	
				2	Infants	Arithmetic		Writing	Reading		2	Mental Arithmetic	Writing	Amusements	
				3	Infants	Figures		Reading	Writing		3	Mental Arithmetic	Figures	Amusements	
Thursday.				1	VI.-VII.	Arithmetic		Geography	Copy Books		VI.-VII.	Same as Tuesday.			
				2	V.	Arithmetic		Geography	Copy Books		V.				
					IV.	Arithmetic		Geography	Copy Books		IV.				
				3	III.	Arithmetic		Reading	Transcription		III.				
				4	II.	Arithmetic		Transcription	Reading		II.				
				5	I.	Memory Writing		Arithmetic	Reading		I.				
				1	Infants	Reading		Writing	Arithmetic		Infants. 1				
				2	Infants	Writing		Reading	Tables		2				
				3	Infants	Figures		Figures	Reading		3				
Friday.				1	VI.-VII.	(B.) Arith. (G.) Cook.		(B.) Read. (G.) Cook.	(B.) Eng. (G.) Cook.		VI.-VII.	Drawing	Drawing	Drawing	
				2	V.	(B.) Arith. (G.) Cook		(B.) Read. (G.) Cook.	(B.) Eng. (G.) Cook.		V.	Drawing	Drawing	Drawing	
					IV.	(B.) Arith. (G.) Cook.		(B.) Trans. (G.) Cook.	(B.) Read. (G.) Cook.		IV.	Drawing	Drawing	Drawing	
				3	III.	Arithmetic		English	Dictation		III.	Drawing	Drawing	Drawing	
				4	II.	Arithmetic		Dictation	English		II.	Drawing	Drawing	Drawing	
				5	I.	Geography		Copy Books	Reading		I.	Drawing	Drawing	Drawing	
				1	Infants	Arithmetic		Writing	Reading		Infants. 1	Singing	Object Lesson	Poetry	
				2	Infants	Writing		Reading	Arithmetic		2	Singing	Object Lesson	Poetry	
				3	Infants	Writing		Figures	Reading		3	Singing	Object Lesson	Poetry	

N.B.—All the Girls are Sewing on Tuesday and Thursday Afternoons. Standards IV.-VII. Girls are at Cookery on Friday Mornings from 9.40.

a saucer now; when this job's over, it will be ekal to a dinner plate! (*Three cheers heard within.*)

There they go! That's three cheers for the Squire, I s'pose! Well, they're good-hearted boys, though they be uncommon fond of a bit o' mischief! There, there, I was just like it myself!

Somehow or other I don't know how to take the Squire to-day, one minute he's all jollity, and the next all thoughtful like! To-day's his birthday! Now, what can a man want with another birthday who's had over fifty already? I'm precious glad to forget mine! But no, nothing will do but he must have his 'dear boys,' as he calls 'em, over to dinner to celebrate the fifty-fifth joyful occasion! Now, I have a soft place here for the boys myself; but, if I wanted to enjoy a day pertickelrly much, I should get as far from the young gents as a pair of shaky old legs would carry me! (*goes on one knee to put some trifles into the waste-paper basket.*) But there's no accountin' for ——

Enter the boys in a troop—they overturn Smithers in their eagerness—the smaller boys enter first, then the bigger ones more quietly.

Durling (*helping Smithers rise*): Halloa, Smithers! I beg your pardon! Are you all right now? How's your father? How's your mother? How's your aunt?

Smithers: Oh, pretty well, *Mr.* Durling! How's your *nurse?*

All (*laughing at Durling*): Bravo, Smithers, that was one for himself!

Martin (*head boy*): Now, you small fry, just be a little quieter, or you'll have to have some of the impudence taken out of you. Look here, Smithers, the Squire has sent us in here for a few minutes while he looks round the stables and kennels; but what's more, he says that you will entertain us till the sports begin. So fire away, old fellow, we are all attention!

(*All form a quadrant opposite Smithers—smallest in front.*)

Smithers: Oh, Mr. Martin, you know I'm always ready to amuse the boys—Oh, certainly!—er—er—How did you like your dinner, boys?

Berry (*one of the tallest*): Never mind the dinner, that's Ancient History now! You've got to amuse us, so set about it at once! What do you say, boys?

All: Hear, hear! Hear, hear!

Nelson, major: Go it, Smithers! Say something funny!

Smithers: Oh, yes—yes—something funny—something to make you laugh!—er—er—How did you like the chickens, boys?

All: Shame! Shame!

West: Smithers, there's no subject so utterly used up as a dinner that you've eaten; so say no more about that, or we'll report you! Your orders are to amuse us, and I hope you'll soon begin!

Smithers: What shall I do? I'm not funny.

West: I say, tell us some stories—good side-splitting ones! Is that it, boys?

All: Hear, hear! A story, Smithers!

(*All strike an attitude of intense attention.*)

Smithers: Oh, yes! Some stories—real funny ones, boys—er—er—once on a time—er—er—twice on a time I should say—er—er—Ah! How did you like the *jelly*, boys?

All: Shame! Shame! (*Some in front*) Tell the Squire!

Martin: Now, come, Smithers, this is getting serious! I tell you we've had enough of the dinner, especially Blackwell there (*indicating the plumpest boy present. Several boys*: Hear, hear!) And now we are impatiently waiting to be amused by you. Now, if you don't at once commence operations, we shall have to amuse ourselves! Are those your sentiments, boys?

All: 'Exactly.' 'Certainly.' 'To a T, Martin.'

Stuart: Can't you conjugate a French verb—*that* would be amusing, I'm sure! Here's a start,—(*very rapidly*) Je parle, tu parles, il parle, nous parlons, vous parlez, ils parlent. Cut away!

Smithers (*attempts*): Pa—pa—pa—No, no, no!

Nelson, minor: Then decline a Latin noun,—Mensa, mensæ, mensæ, mensam, mensa, mensâ. Decline away!

Smithers: I keep on declining lots of things, but you're not satisfied!

Berry: He's beginning! It's all right! Get ready to laugh; but mind the buttons on your waistcoats!

Durling: I have an idea! A speech! Smithers shall make an oration in praise of Dr. Daymond's Grammar School, and the quiet set of boys there! Who's for a speech?

All: All! All!

Smithers (*thumb in vest*): I'm much obliged to you children—('Smithers!') to you young men—('That's better!') for the—er—*h*onour—

Baker: Honour, Smithers!

Smithers: I said *h*onour—didn't I say *h*onour, boys?

All: Certainly you did, go on!

Smithers (*looking at Baker*):—for the *h*onour you—er—er—Oh, how did you like the *tarts*, boys?

All (*threatening him*): Shame! Shame!

Blizard: Tell his mother-in-law!

Berry: Smithers, if you mention that dinner again, you'll not escape from here alive! There's only one thing left for you to do, and that you positively must do—sing a song! Boys, would it amuse you to hear Smithers sing?

All: Yes, yes! A song! Bravo!

Durling (*waving his hand*): Signior Smitherino will oblige!

Smithers: That's the very thing, boys! I'll sing with pleasure! I'd forgotten that! But you're quite sure it will amuse you?

All: Oh, yes! Go on!

Smithers (*aside*): Oh! I wish the Squire would come! (*Aloud*) I only know one, mind, so no *hencores!*

All: No, no! Go on! Sing!

Smithers (*aside*): Oh, Squire, do come! (*Aloud*) Oh, p'raps I'd better tell you a little about it first?

Porter: Well, what's the name of it?

Smithers: It's called, 'It was my father's custom.' It's about 'Horanges from Sportigal, and Grapes from Sunny Spain.' Would you really like to hear it?

All: Of course!

Smithers: Mr. Martin, I hear you're a bit of a player, will you support me on the pianer?

Martin: Come along! Where's your music?

Smithers: Oh, ah, my music! Of course you can't

sing without music! Let me see, where did I put it? Oh, yes, it's in my pantry—I'll go and fetch it!

(*Tries to go—boys drag him back.*)

All: Stop him! Stop him!

Berry: Never mind the music, sing without!

Smithers: All right, I don't mind! I only thought it would amuse you all the more to hear me down here, and the pianer up there!

Nelson, major: You go on singing!

Smithers: Well, p'raps I ought to warn you that when I open my mouth to sing, I always shut my eyes—so! Which reminds me that I sang this song once before at a party of friends. When I began, the room was full, and when I had finished, it was quite empty!

Martin: Why did they leave, Smithers?

Smithers: They all said my voice sounded better at a distance, and one young page-boy actually said I ought to take lessons. Don't you think you had better go on the lawn to listen?

Nelson, major: Certainly, Smithers! Who's for the lawn?

All: Hurrah! The lawn! Come on!

Durling: No larks, Smithers! (*Part exit.*)

(*As the boys go towards the door, they are met by the Squire, who drives them back again.*)

Squire Hearty: Now, boys, what's this? Are you tired of the hospitality of the Hall already?

Martin: Oh, no, sir! Smithers, in his anxiety to amuse us, is going to sing from the study window, while we listen on the lawn!

The Squire: Well, I'm sorry to spoil the fun, but just at present I have other fish for Smithers to fry! Smithers, just see the things cleared away in the dining-room, and let us know when the lawn is ready for the sports. But, stay, first bring me my silver hunting-watch from the dinner table; I left it beside my plate!

Smithers: Very good, sir! (*Exit.*)

The Squire: And, now, boys, you shall have your music after all, only you shall be the performers yourselves. Sing me something you learn at the Doctor's. I dare say I shall fall asleep; I always do after a meal; but wake me up at the end, and I'll take my turn.

All: Bravo, bravo!

The Squire: Slip the leashes, Martin, and let them go. (*Sits in his arm-chair.*)

Martin: Well, boys, what shall we send the Squire to sleep with?

Berry: Let us try 'Those Evening Bells.' The Squire will snore by the third verse.

(*All sing* 'Those Evening Bells,'* *standing opposite to his chair, and in the form of a quadrant. Martin, or any one else, may accompany lightly on piano.*)

The Squire (*much moved*): Thank'ee, boys, thank'ee! It's almost too sad for brats like you; but you must have pitched upon it by witchcraft to suit me to-day, for, as you will learn before you go, I am thinking much of the time 'When other Squires shall walk these dells, and hear your praise, Sweet Evening Bells.' But there, there! It's my turn now! What shall I sing you?

All: 'A-hunting we will go,' sir!

The Squire: You young rogues, you know it's the only song I ever sang in my life! Give me a start now! How does it begin?

All (*singing at various pitches*): 'The dusky night rides down the sky.'

(*All laugh, the Squire included.*)

The Squire: That's like a modern gimcrack song, published in every key! (*Clearing his throat.*) Well, here goes!

(*Sings* 'A-hunting we will go'* *as he sits on corner of study table, opposite the door, hunting crop in hand, and hat on head. At the end, boys cheer loudly,—Squire takes off hat and bows,—all laugh heartily,—accompaniment* ad lib. *Enter Smithers excitedly, while all are laughing.*)

Smithers: Sir! Sir! It's gone! It's gone!

(*Crosses to R. of Squire.*)

The Squire: What's gone? The song, or your sense of politeness? Take care of your other senses, Smithers, or they'll go too!

Smithers: Don't joke, sir! I'm serious! It, sir,—the watch—your silver hunting watch is gone!

The Squire: Well, it has been *going* these fifty years, so that I'm not a bit surprised to hear it has *gone!* But where has it gone to?

Smithers: I cannot tell! No one, but we two and the boys, has been in the dining-room, and I cannot find the watch anywhere. P'raps one of the boys is larking with it, sir!

The Squire: I took my watch from my pocket—seals and all—and placed it at the side of my plate just as dinner began. It is a habit of mine, to save the trouble of turning to look at the clock at my back. Now, did you look there, Smithers?

Smithers: Yes, sir, I know where you always put it; but I've searched everywhere, and cannot find it!

Martin: Did you leave it in the stables, sir?

The Squire: No. It was on my way there that I remembered I had left it on the table. Did any boy see it there during dinner?

Berry: Your godson, Durling, sat on your right, sir!

Durling: Oh, yes! I remember seeing it quite well!

The Squire: Well, never mind, boys, it will turn up some day, no doubt. Let us go on with the fun!

Smithers: Boys, listen! I know my dear master better than you do. When you are gone, and the watch can't be found, master will fret and worry over it more than you think, for nothing troubles him so much as a mean action. Now, come, some boy *must* have it! Give it to the Squire—say it was a boyish trick (for I know not one of you would do a dishonest thing)—and, then, I know he'll laugh with the best of you!

Nelson, minor: Sir, I hope I am no tale-bearer, but I think I ought to mention what I saw a few minutes ago, so that no one may be wrongly suspected. You remember, towards the end of the dinner, we all jumped to our feet when we thought we saw the figure of a tramp pass across the lawn, and before the dining-room window. Well, just at that moment, I saw Durling slip something from the table into his pocket as if he did not wish to be seen!

(*Durling instinctively puts his hand to his pocket.*)

* Published by Curwen & Sons, Warwick Lane, London, E.C., as an easy three-part song.

* Old English song, easily obtained.

Nelson, major: See, he has something there now! (*To Durling*) Give it up if you've got it, there's a dear fellow!

The Squire: Willy, my boy—mind, I don't suspect you for a moment—show the boys what you have in your pocket!

Durling: Oh, sir! I cannot! I really cannot! But I haven't touched the watch! I would die, sooner than do such a thing!

Martin: Look here, boys, this must be cleared up before one of us leaves this room. I believe no boy in our school would do a down-right dishonest action; but, we must think of the good old Doctor at home. Even to have one of his boys suspected of such a thing as stealing a watch—and the Squire's watch above all others—would cut him to the heart. Why, before we came away, the Doctor called Berry and me aside and said he was not coming with us for fear of spoiling our day with anything like overseeing; but, he also said that he depended on us two for seeing that nothing was done to bring discredit on the school. Now, it's not a pleasant thing to undergo, but I for one will consent that Smithers search my pockets, rather than a horrible suspicion should rest on the old Grammar School. Now, who'll be another?

All: 'I will, Martin!' 'I will!' 'And I!' &c., &c.

Berry: What does Durling say?

Durling: I say, all of you, don't suspect me, don't suspect me! But I can't be searched—Oh! What shall I do? Give me another chance! Go out of the room for two minutes, and I'll tell all to the Squire!

Martin: Well, boys, let us go! (*All troop out, Martin and Berry last, arm-in-arm.*) Don't be hard on him, sir, he's the pet of the school!

(*Exeunt Martin and Berry.*)

(*The Squire sits in his chair near table in a thoughtful manner. Durling, falling on one knee before the Squire, takes out small parcel from his jacket pocket, places it on table within reach of the Squire, and then buries his face in his hands.*)

The Squire (*slowly opening parcel*): What! The leg—the leg of a chicken!

(*Holds it aloft, and then bursts out laughing.*)

Durling (*still kneeling*): Yes, sir, the *off* leg of a chicken! Can you ever forgive me for being so mean?

The Squire (*raising him*): Forgive you, boy? Why, it was your own! So this is what you didn't want the boys to see, eh? But what possessed you to put it in that pocket of yours on the sly? You might have had a hen and all her brood if you had wished it!

Durling: Well, sir, you know mother is not very well off, and besides me, there is a little invalid sister at home, the dearest, sweetest little sister anywhere. Well, we don't of course get many little nicknacks to tempt the pet with, or she might be stronger! Well, just as I was starting to come here, she called out from the sofa where she lay, half in fun and half in earnest, 'Bring me home something nice, Willy!' So when the leg of the chicken looked so brown on my plate, I thought 'That will just do for little Lucy!' Then, when I fancied I had a chance, I just slipped it in my pocket, and here it is! But I didn't eat chicken and pocket it too—I waited for the tarts!

The Squire: Spoken like a little man, Willy! Shall I call the other fellows and tell them all about it?

Durling: No, sir, pray don't tell them all! They know you took me from the Commercial and paid for me to be a day-boy at the Grammar School; but, for the sake of mother and Lucy, I shouldn't like them to think we wanted food. It wasn't that, sir!

The Squire: All right, Willy, you're worthy of the best of mothers, and the sweetest of sisters! (*Calling at the door.*) Here, you fellows, come in! (*The boys enter in a group.*) Shake hands with him, he's as innocent as a babe! Shake him hard, there's not a better fellow in the room!

All (*shaking hands*): Bravo, old chap! We knew it was all right! Where is it? What did you ——

(*Enter Smithers hurriedly. He gives the Squire a card.*)

The Squire (*reading*): Well, well! Mystery on mystery! Show him in, Smithers. (*Exit Smithers.*) Here's a visit from a Bow Street detective. Our village is getting on!

(*Enter Price, a detective, and Smithers.*)

The Squire: Well, Mr. Bow Street—I beg your pardon—I mean Mr. Price, what is your business?

Price: Well, I ain't used to beatin' about the bush, so this it is. Numerous complaints 'av reached the London Office of various burglaries and petty larcenies takin' place in this 'ere districk. Local men 'av been put on the track time after time, but to no puppose, so I receives orders a week ago to try my 'and at ketching somebody. Well, nothing of any consequence turned up till to-day, when, not fifteen minutes ago, as I was looking round the country from the hill yonder, with the best pair of glasses London can provide, I spies some one in the dress of a yokel drop out of your dining-room window, and make off like greased lightning. I was soon across the fields, being then in countryman's clothes also, and, by the footprints in the soft ground, I soon tracked my gentleman to that small public at the bend of the lane. Slipping a pair of cuffs on his wrists, I *offered* to give him a ride in a trap I had 'andy to the village lock-up. There we took the liberty of seeing what he might 'av in his pockets—and this is the result of our inquisitiveness! P'raps you know the harticles?

(*Gives packet to Squire.*)

The Squire: Know them! Do I know my own features when I see them in the glass? Boys, look here—here's the watch—the very watch and seals I laid on the table at dinner time!

All (*including Smithers*): Hurrah! Hurrah! Bravo, Bow Street!

(*Price bows; all shake hands with one another.*)

The Squire: I knew it was all right, and would come to light!

Martin: Durling, you'll forgive the boys, won't you? We were wrong to suspect you, even for a moment!

Durling: That's all right, you know! It was partly my own fault!

The Squire: Well, all's well that ends well! But before we go to the sports I wish to make an announcement to you all. I am, as you know, an old bachelor without kith or kin. I shall not last for ever; so before you came to-day I made up my mind to

choose one of you boys as my adopted son and heir. I want to think that my acres and my money will be in safe keeping when I am gone. You are all good boys and true, but one of you has shown to-day, that, young as he is, he can think of the widow and the fatherless, even in the midst of plenty. Durling, that young rogue there, I choose to succeed me, and he shall add to the family crest—for reasons best known to ourselves—the leg of a chicken. Three cheers for your future Squire!

All: Hurrah! Hurrah! Hurrah!

Martin: Three cheers for the present Squire!

All: Hurrah! Hurrah! Hurrah!

Blackwell: Three cheers for the Squire's chickens!

All (laughing): Hurrah! Hurrah! Hurrah!

Curtain.

'ROBERT OF SICILY.'

(HENRY WADSWORTH LONGFELLOW.)

TEXT.

The Pope received them with great pomp, and blare

Of bannered trumpets, on St. Peter's Square,

Giving his benediction and embrace,

Fervent, and full of apostolic grace.

While with congratulations and with prayers

He entertained the Angel unawares,

Robert, the jester, bursting through the crowd,

Into their presence rushed, and cried aloud—

'I am the King! Look, and behold in me

Robert, your brother, King of Sicily!

This man, who wears my semblance to your eyes,

Is an impostor in a king's disguise.

Do you not know me? Does no voice within

Answer my cry, and say we are akin?'

The Pope in silence, but with troubled mien,

Gazed at the Angel's countenance serene;

The Emperor, laughing, said—'It is strange sport

To keep a madman for thy fool at court!'

And the poor, baffled jester in disgrace

Was hustled back among the populace.

In solemn state the Holy Week went by,

And Easter Sunday gleamed upon the sky;

The presence of the Angel, with its light,

Before the sun rose, made the city bright,

ANNOTATIONS.

(149) *pomp*, stately procession. (Lat. *pompa*, Gr. *pompe*.)

(149) *blare*, loud noise.
Cf. 'The unexpected blare of trumpeting.' (Carlyle, *French Revolution*.)

(150) *bannered trumpets*, trumpets with small flags suspended from them, as still used by heralds in making royal proclamations.

(150) *St. Peter's Square*, the huge open space in front of the Cathedral at Rome.

(151) *benediction*, blessing pronounced by a bishop or priest. (Lat. *bene*, 'well,' and *dicere*, 'to speak.') Cf. the 'Apostolic Benediction' which concludes 'Morning and Evening Prayer' in the Anglican Service—II. Cor. xiii. 14.

(151) *embrace*, welcome, by enfolding in the arms.
Cf. 'Thames, the most loved of all the ocean's sons
By his old sire, to his embraces runs.' (Sir J. Denham.)

(152) *Fervent*, warm with love. (Lat. *fervens*.)

(152) *apostolic*, belonging to, or becoming an apostle. An apostle was one sent forth to preach. (Gr. *apostolicos*, from *apo* and *stellow*.)

(152) *grace*, favour, or with suitable dignity.

(153) *congratulations*, professions of joy and sympathetic pleasure. (Lat. *con* = with, and *gratulari* = to wish joy.)

(154) *entertained . . . . . unawares*, made a guest of an Angel without knowing it. The expression is borrowed, literally, from Heb. xiii. 2, 'Be not forgetful to entertain strangers, for thereby some have entertained Angels unawares.' The word 'some' in this text has reference to Abram.

(159) *semblance*, likeness. (Fr. *semblance* = appearing.)
Cf. 'Their semblance kind, and mild their gestures were.' (Fairfax.)

(162) *akin*, related.

(163) *mien*, manner. (Fr. *mine*.)
Cf. 'Vice is a monster of so frightful mien.' (Pope.)

(164) *countenance*, face. (Fr. *contenance*.)

(164) *serene*, calm. (Fr. *serein*, Lat. *serenum*.)

(167) *baffled*, foiled, with idea, also, of being mocked. (N. Fr. *beffler* = ridicule.)

GRAMMATICAL 'HINTS.'

(149) *blare*, noun, objective after 'with.'
(151) *Giving*, participle, imperfect, referring to 'Pope.'
(151-152) *Giving . . . . . grace*, participial phrase, extension of predicate to 'received.'
(152) *fervent*, adjective, qualifying 'embrace,' and 'benediction.'
(153-154) *While . . . . . unawares*, adverbial clause, modifying 'rushed.'
(153) *while*, subordinate conjunction.
(155) *jester*, nominative in apposition with 'Robert.'
(156) *aloud*, adverb of manner, modifying 'cried.'
(157) *Look, behold*, verbs in the imperative mood, subject 'thou.'
(157) *in me*, indirect object.
(158) *brother, king*, objectives in apposition with 'Robert.'
(157-162) These lines may all be regarded as a noun clause, but see note to line 9.
(159) *This*, distinguishing adjective.
(159) *who . . . . . eyes*, adjective clause, qualifying 'man.'
(160) *is . . . . . disguise*, predicate of 'man.'
(161) *Do*, auxiliary of interrogation (not emphatic).
(161) *know*, infinitive mood.
(161) *Does*, present tense, 3rd person, singular number, of the verb 'do.'
(161) *within*, adverb or preposition, but here used adjectivally with 'voice,' or might be regarded as a preposition governing (you).
(162) *we are akin*, noun clause, object to 'say.'
(163) *in . . . . . mien*, extension of predicate to 'gazed.'
(164) *serene*, adjective of quality to 'countenance.'
(165) *laughing*, participle, imperfect, referring to 'Emperor.'
(165-166) *It . . . . . court*, see line 9.
(165) *It*, impersonal pronoun.
(165) *sport*, nominative after 'is.'
(166) *To keep . . . . . court*, infinitive phrase, adjunct to 'it.'
(168) *Was hustled*, passive voice.
(168) *populace*, collective noun.
(169) *went*, past tense of 'go'; borrowed from the old verb 'wend' (A.S. wendan).
(169) *by*, adverb of place.
(169-170) These lines form two simple sentences.
(171-174) These lines form two complex sentences.
(171) *its*, personal pronoun, singular, neuter, possessive case limiting 'light.'
(172) *Before the sun rose*, adverbial clause, modifying 'made.'
(172-173) *made, filled*, predicates of 'presence.'
(174) *Who felt*, adjective clause, qualifying 'men.'

PARAPHRASE.

The two Princes met with a grand ceremonial reception at Rome. The Pontiff publicly welcomed them in the open space before the stately Cathedral; and, amidst the shrill sound of pennoned clarions, bestowed his blessing upon his royal visitors, enfolding them in his arms, with all the warm-hearted affection and kindly dignity which well became the successor of St. Peter. Little dreaming of the sacred nature of his Celestial Guest, Urban was expressing to Him the deep satisfaction with which he had heard of the prosperity of Sicily, and his earnest desire for its continuance, when the impetuous fool suddenly appeared before them and loudly asserted his regal rights and his claim to be the Pontiff's kinsman. As in the hall at Palermo, he again denounced the Being who bore his likeness as nothing more than an impudent usurper. There was something strangely touching in his sad, but futile, appeal to the natural instincts of relationship. Urban, with mute but perplexed enquiry, turned to the Angel, whose calm face afforded no solution of the cause of so daring an interruption. Valmond merrily professed himself unable to see any fun in the employment of a lunatic as a king's jester. Once more foiled in his attempts to regain his throne, poor Robert was ignominiously thrust back into the crowd of citizens who had been witnessing his strange behaviour.

Passion Week, with all its devout observances, was over, and the morn of the Resurrection Feast brightly dawned upon

TEXT.	ANNOTATIONS.	GRAMMATICAL 'HINTS.'	PARAPHRASE.
And with new fervour filled the hearts of men,	(168) *hustled*, rudely pushed. (Low. Ger. *hutselen* = crowd or press.)	(174) *that ..... again*, noun clause, object to 'felt.' (174) *indeed*, adverb of emphasis, modifying 'had risen.' (174) *again*, adverb of repetition, modifying 'had risen.' (174) *had risen*, past perfect tense.	the horizon. But the first beams of the rising orb of day were anticipated in their radiance by the halo of light which shone o'er the 'seven hills' and enkindled, in the bosoms of all who beheld it, a new realisation of the truth and benefit of Christ's conquest over Death. Robert, himself, was not beyond the reach of this hallowing influence. Lying there on his rough couch, his wearied gaze was quickened by the Angelic glory which pervaded the city. A new and irresistible impulse brought him to his knees, whilst to his ears there came a sound as if the rustling robes of the risen Lord were cleaving the still morning atmosphere and passing onwards through the firmament to the gates of Paradise.
Who felt that Christ indeed had risen again.	(168) *populace*, multitude in the streets. (Lat. *populus* = the people.)		
Even the jester, on his bed of straw,	(169) *Holy Week*, the week preceding Easter Day, also called Passion Week. In it we commemorate the closing scenes of Our Lord's life amongst men, *e.g.* the Betrayal, the Agony in the Garden, and the Crucifixion.	(175) *Even*, adverb modifying 'saw.' Latham says that *even* used in this sense is a 'word of exaggeration' by which a mental comparison is implied, *e.g.* 'even the great,' *i.e.* 'the great *like* the mean.' (176) *unwonted*, negative participial adjective. (176) *saw*, predicate of 'jester.' (175-180) These six lines form a compound sentence, consisting of three simple sentences, of which lines 178-180 form the third. (177) *unfelt*, negative participial adjective. (178) *kneeling ..... floor*, participial phrase, adjunct to 'he' (179). (180) *sweep*, infinitive, governed by 'heard.' (180) *ascending*, participle, imperfect, referring to 'Lord.' (180) *heavenward*, adverb of direction, modifying 'ascending.' (181) *And now*, conjunctive phrase. (181) *visit*, nominative absolute to the participle 'ending.' (181) *ending*, participle, imperfect, referring to 'visit.' (181) *once more*, adverbial phrase, modifying 'returning.' (182) *Valmond*, nominative absolute. (181-186) These lines form a compound sentence, consisting of two simple sentences, with predicates 'journeyed' and 'was made resplendent.' (184) *was made*, passive voice; 'made' is the past tense of 'make.' (184) *resplendent*, adjective, qualifying 'land' factitively. (184-186) *with ..... sea*, extension of the predicate 'was made,' etc. (186) *thence* = that place; an adverb here used as a noun, objective case, governed by 'from.' (187-192) These lines form a complex sentence, with 'beckoned' as its main predicate. (187-189) *when .... towers*, adverbial clause of time, modifying 'beckoned.' (187-188) *once ..... hall*, extension, partly of time, partly of place, to predicate 'heard.' (190) *As ..... ours*, adverbial clause of manner, modifying 'heard.' (190) *As if*, conjunctive phrase, introducing the adverbial clause. (190) *ours*, possessive pronoun, objective governed by 'with.' (191) *to King ..... nigher*, infinitive phrase, indirect object to 'beckoned.' (191) *nigher*, adverb of direction. (192) *retire*, infinitive, governed by 'bade.' (193) *alone*, adverb of place, modifying 'were.' (194) *Art*, 2nd person singular of the verb 'to be'; not auxiliary. (195-196) *crossed, answered*, predicates of 'Robert.' (196) *him*, indirect object; the quotation 'Thou knowest,' etc. is the direct object. (196) *knowest*, 2nd person. (196) *best*, not the superlative of 'good,' in this instance, but an adverb of degree, modifying 'knowest.' (Latham.) (197) *as scarlet*, may be regarded as a preposition and a noun, 'as' having the force of 'like.'	The time for departure having arrived, the Emperor returned to Vienna, and Robert's Master made his way back to Sicily. The goodly company passed southward with glittering brilliancy through Naples to the port on the bay beyond, at which they took ship for Palermo. When within the bounds of the royal city, and again occupying his chair in the great banquet-chamber, the Angel heard the sound of the bell from a neighbouring monastery come floating into the palace. The monks were reciting the Salutation to the Blessed Virgin Mary, and it seemed to him that Heaven talked with earth. He then motioned to the jester to approach him, and, having dismissed his retainers, once more put to the now repentant monarch the oft-repeated enquiry. Bending low, with every sign of contrition, the conscience-stricken King humbly replied that the Angel was the one to judge. In scriptural phrase he acknowledged his guilt and implored his Celestial Mentor to permit him to depart, that he might enter some convent, where, by appointed discipline, he might cleanse his sinful spirit, and so
And when once more within Palermo's wall,			
And, seated on the throne in his great hall,			
He heard the Angelus from convent towers,	(189) *Angelus*, a prayer sung thrice daily in the Latin Church and addressed to the Virgin Mary. In Roman Catholic countries a bell (also called the Angelus) may be heard sounding from the turrets of convents into the country around, and announcing to all within hearing distance that the prayer is being said. Millet, the great French painter, has a picture, representing a scene in Brittany, in which some peasants, working in the fields at eventide, hear the bell, and, resting with bowed heads upon their implements, recite the Angelus. (Lat. *Angelus* = the Angel; the prayer contains the 'Salutation' of Gabriel to the Blessed Virgin, and begins, 'The Angel of the Lord.')		
As if the better world conversed with ours,	(190) *conversed*, discoursed, talked.		
He beckoned to King Robert to draw nigher,	(191) *beckoned*, made a sign without speaking. (A.S. *beacnan*.)		
And with a gesture bade the rest retire;			
And when they were alone, the Angel said—	(191) *nigher*, an Americanism.		
'Art thou the King?' Then bowing down his head,			
King Robert crossed both hands upon his breast,	(192) *gesture*, motion of the hand or head expressing a command or wish. (Lat. *gero* = to carry.)		
And meekly answered him — 'Thou knowest best!			
My sins as scarlet are; let me go hence,	(192) *retire*, withdraw.		
And in some cloister's school of penitence,			
Across those stones, that pave the way to heaven,			
Walk barefoot, till my guilty soul is shriven!'			

TEXT.	ANNOTATIONS.	GRAMMATICAL 'HINTS.'	PARAPHRASE.
The Angel smiled, and from his radiant face	(197) *My sins as scarlet are, i.e.* 'I realise the depth of my own wickedness.' The expression is borrowed from 'Though your sins be as scarlet,' Isaiah i. 18.	(197) *let*, imperative. (197) *go*, infinitive. (197) *hence*, adverb of direction from, modifying 'go.'	prepare himself for Divine pardon. The Angel's countenance revealed the inner joy with which he accepted Robert's submission, and his glad look of pleasure lit up the surrounding air. Then, through the lattice near, with startling distinctness, not drowned by the sounds of city life, came stealing the solemn words of the Magnificat, wafted from the lips of the choir in a neighbouring House of Prayer. As the Canticle, with familiar tones, bore its inner meaning into Robert's mind, there was mingling in his ears another refrain which, with clear note as of a rich harp, seemed to reveal to him the Heavenly Personality of him whose mission was now over.
A holy light illumined all the place,		(198) *some*, indefinite numeral adjective.	
And through the open window, loud and clear,	(198) *cloister*, an open court generally attached to monasteries; also used for any place of religious retirement. (Fr. *cloître*, Lat. *claustrum*.)	(199) *that . . . . . heaven*, adjective clause, qualifying 'stones.'	
They heard the monks chant in the chapel near,		(200) *walk*, infinitive, governed by 'let' (197).	
Above the stir and tumult of the street—	(198) *school of penitence*, a place where he might learn to have sorrow for past sins, and endeavour to amend his life. (Lat. *penetentia*.)	(200) *barefoot*, adverb of manner, modifying 'walk.'	
'He has put down the mighty from their seat,		(200) *till* subordinative conjunction.	
And has exalted them of low degree!'	(199-200) These lines refer to an act of peaance, viz. walking barefoot on the cloister floor. It is said that the stone floors of monasteries have actually shown the track made by the bare feet of monks engaged in penance.	(200) *is shriven*, passive voice.	
And through the chant a second melody		(203-205) *And . . . . . street*, principal sentence, predicate 'heard.'	
Rose like the throbbing of a single string:	(200) *shriven*, the perfect participle of the verb 'to shrive,' which means for a priest to hear confession and to pronounce absolution. (A.S. *scrifan* = to confess.) Cf. 'Where holy fathers wont to shrive.' (Spenser's *Shepherd's Calendar*.)	(203) *loud* — loudly, adverb of manner.	
210 'I am an Angel, and thou art the King!'		(204) *chant*, infinitive, governed by 'heard.'	
	(202) *illumined*, lit up.	(204) *near*, equivalent to 'neighbouring,' adjective qualifying 'chapel.'	
King Robert, who was standing near the throne,		(205) *Above . . . . . street*, extension of predicate to 'heard.'	
Lifted his eyes, and lo! he was alone!	(205) *tumult*, commotion. (Fr. *tumulte*.)	(206) *put down*, a compound of verb and adverb (rendering Deposuit). Latham gives 'put down' as a verbal expression. It is transitive.	
But all apparelled as in days of old,		(206) *mighty*, adjective, used as a noun, objective case, governed by 'put down.'	
With ermined mantle and with cloth of gold;	(208) *melody*, sweet, musical air. (Lat. *melos*, and Gr. *melodeia*.)	(208) *second*, ordinal, numeral adjective.	
And when his courtiers came, they found him there		(209) *like*, preposition, relating 'throbbing' to 'rose.'	
Kneeling upon the floor, absorbed in silent prayer.	(209) *throbbing*, beating. (Swedish *drabon*, A.S. *drub*.) Cf. 'It throbs with fear and aches at every sound.' (Addison's *Cato*.)	(212) *lo!* interjection.	
		(212) *alone*, adverb of state or condition.	
	(212) *lo*, behold.	(213) *all*, adverb of degree, modifying 'apparelled.'	
		(213) *of old*, prepositional phrase, equivalent to 'olden,' and used as an adjective, qualifying 'days.'	
	(213) *days of old*, before his dethronement.	(215) *when . . . . . came*, adverbial clause, modifying 'found.'	
		(215) *there*, adverb of place, modifying 'found.'	
	(216) *absorbed*, taken up, wrapt. (Lat. *absorbeo*.) Cf. 'And dark oblivion soon absorbs them all.' (Cowper.)	(216) *absorbed*, perfect participle, referring to 'him.'	

THE END.

CONVERSATIONAL LESSONS IN CHEMISTRY.

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For particulars of the List of Chemicals and PRACTICAL TEACHER Set of Apparatus for working the experiments referred to in these lessons see numbers for January and February 1893.

LESSON XVIII.—LEAD.

WE shall now proceed to examine a few of the more common metals and their salts, beginning with the very common substance that you see on the table before you. Take it up and examine it, Charlie, and tell us what you think it is. It is lead, sir; I can tell that at once by its weight. Get out the balance, Fred, and let us see how water and lead stand with respect to weight. I think I have told you already that we express the weight of solids and liquids by comparing them with the same bulk of water, the number which tells how many times the substance is heavier than water being called the *specific gravity* of the substance. We are therefore bent upon determining the specific gravity of lead. Here is a cube of lead just one inch each way, *i.e.* a cubic inch. Before putting the lead in the balance pan, we will first counterbalance the large beaker which is in the other pan, with shot. Now place the cube of lead in the pan and pour water into the beaker until the lead is balanced thereby. In our arithmetic lesson we will calculate how many cubic inches of water are required to balance the lead. We shall find that it will be about $11\frac{1}{2}$, hence we say that the specific gravity of lead is 11·5. As the specific gravity of platinum, the heaviest of all metals, is only 21·3, we class lead amongst the *heavy metals*. Now, Arthur, please scrape the specimen and tell us what you observe. It has *metallic lustre* and is bluish-grey in colour. Very good. But what is this papery stuff that I have taken from round my tobacco? It is silver-paper, sir. Do you really think it is made of silver? Oh no, sir, that would be too dear. Well, what is it? Lead, sir. Yes; it is lead, as you might easily see from the fact that it marks paper when drawn heavily across it. Here is also some leaden wire. Try it, Tom. It is not very strong, sir. No, and for that reason is not used as wire. Now what does the lead paper prove, Annie? That lead is very malleable. Exactly; and now, Trixie, what does the wire show? That lead is ductile. Yes, but not very tenacious. Minnie, please bring here that melting spoon and place therein these small pieces of lead, and heat over the bunsen. See, it melts. Would iron melt so easily? No, sir. Lead, then, for a metal, has a low melting point. Its melting point is about 330° C., or nearly one and three-quarter times the boiling point of water. Now, Ernest, take this long tube and through it blow on the surface of the molten lead. Well, what do you notice? There is a yellow scum there, sir. Quite right. And now go a step further and say what you think that scum is? Is it not an oxide, sir? Before I answer your question let us compare the yellow scum with the contents of this packet, which, as the label informs you, contains litharge, or lead oxide—PbO. They are both the same, sir, and my answer was right. Yes; and as a reward

for your discrimination you shall work the next experiment. Take another spoon. Place some litharge in it, and hold the spoon over the bunsen whilst Ernest shall blow under the spoon with his blowpipe in order to get a sufficiency of heat. It is changing from yellow to red, sir. Quite correct. But what is Annie so eager about? Is that red lead, sir? Yes; and you know who uses that, I suppose? My father, who is a painter, sir, uses both red lead and white lead to mix with his paints. Very true. Red lead is a pigment. It is called *minion*, and because portraits used to be painted with this pigment, called for this reason miniatures, this word is now used for a diminutive portrait; of course it really means, made of minion. But to our work. To what class of bodies does red lead belong, Willie? It is an oxide of lead, sir, but I should have thought that heating the litharge would have driven out the oxygen. On the contrary, it causes more oxygen to enter into combination, for red lead is Pb_3O_4, so that whereas in litharge there are three atoms of O to every three of lead, in minion there are four of oxygen to every three of lead.

For our next experiment we require some powdered charcoal, with which we mix a quantity of litharge and heat them together. What would you expect to happen under these circumstances, Tom? The carbon would combine with the oxygen of the litharge and leave the lead behind. Try it, and tell us when you have done whether or no this is so. Here is the lead, sir, so my answer, I suppose, was correct. Yes; and you will remember that carbon is extremely useful in this way to reduce metals from their ores. It is now for you to perform an experiment. Into this test-tube place some litharge, to which add dilute nitric acid and apply heat. Tell us what happens. The litharge dissolves, sir, and leaves a clear solution. Good. Now pour out the liquid into your evaporating dish and again heat until you see some crystals appear. What do you think those crystals are? Well, let Bob tell us, as you cannot. They are crystals of lead nitrate, sir. You have formed a salt by bringing together a base (PbO) and an acid. Very nicely answered; and now let us see what happens when we use the metal in place of the oxide. Well, Fred, what have you noted? The lead is dissolved, sir. What is formed? Lead nitrate, I suppose. Yes; so that you have prepared the nitrate in two distinct ways. Make a solution of the nitrate from the bottle in the cupboard, and to this solution add some hydrochloric acid. What is the white stuff that is produced like? It is just like curded milk, sir. Very true; and now what shall we call it? You answer, Tom. It is lead chloride, sir. Quite right; and as this sort of action is very common, I will put down the equation representing it on the board:

$$Pb(NO_3)_2 + 2\,HCl = PbCl_2 + 2\,HNO_3.$$

Lead nitrate & hydrochloric acid yield lead chloride & nitric acid.

We call this action *double decomposition*, because each body breaks up into two parts, and the two parts of one combine with the two parts of the other to form two new substances. Now, Tom, how could you form lead sulphate? By adding sulphuric acid to lead nitrate. Yes; just as in the former case, double decomposition would ensue. Place some lead in water for me, Charlie. Does it dissolve? No, sir. Quite so. Do we ever put water in lead vessels? Think a minute. Ah! I see what you mean, sir; you mean the lead water-pipes. Yes; and when I tell you that lead compounds are generally very poisonous, you will see how important this question is. Well, Annie, what is it? Please, sir, is it from lead poisoning that painters suffer when they have painter's colic? It is, and a very dreadful disease it is. Moreover, it would be very much better if we could do without leaden water-pipes, for although pure water does not act on pure lead, that does not make us safe, for the lead of pipes is rarely pure, and water, as you know, is never pure. You would, I am sure, like to know what to do if ever you should have to deal with a case of lead poisoning, so I will proceed to tell you. If a substance be insoluble in water or the digestive juices it cannot poison. Hence the thing to do when poison has been taken is to find a substance that will render the poison powerless by making it insoluble. Now the sulphate of lead that you made just now is exceedingly insoluble. Suppose, then, that some sugar of lead (which is lead acetate) has been swallowed. If this is followed up by some Epsom salts, which is magnesium sulphate, double decomposition takes place, and from lead acetate and magnesium sulphate you get magnesium acetate and harmless (because insoluble) lead sulphate. I will give you the equation, in order to further impress this upon your memory:

$$Pb(C_2H_3O_2)_2 + MgSO_4 = PbSO_4 + Mg(C_2H_3O_2)_2.$$

Lead acetate & magnesium sulphate yield lead sulphate & magnesium acetate.

What is your question, Frank? Please, sir, what is white lead? Your question just comes at the right time. We have spoken about the nitrate, the chloride, and the sulphate of lead, and now you lead up to the carbonate, or rather *a* carbonate, for white lead is a peculiar carbonate of lead known as a basic carbonate. You will remember that we said a salt is produced when an acid is neutralised by a base. In some cases, even after the acid has been neutralised, a further portion of the base can be added to the compound, when we get a *basic salt* such as basic lead carbonate. Compare the two formulæ that I am putting on the board and you will understand what I mean:

$PbCO_3$ = lead carbonate.

$(PbCO_3)_2, Pb(OH)_2$ = basic lead carbonate.

You need not trouble much about this, as it is somewhat in advance of your work; still it is interesting, especially as we could not finish our lesson without mentioning such a highly important body as white lead. Look once again at my specimens. What does this look like? It looks like lead, sir. Get a hard glass test-tube out, Lily, and we will see if we can find anything else besides lead. That is right. Incline the tube and heat the contained substance. Now smell. It is just like the smell of burning matches. Yes, but you can do better than that. What is it that gives such a suffocating odour when matches burn? Is it the sulphur, sir? You are not far out; it is the burning sulphur, or rather the body that results from the burning of the sulphur; and pray what is that, Lily? It is sulphur dioxide. Just so, and in this case the oxygen comes from the air and the sulphur from the lead-like substance. If this consists of lead and sulphur, it will be what, Charlie? Lead sulphide, sir. Exactly. This is the commonest ore of sulphur, and is called *galena*. To prepare lead for galena the ore is first roasted in the way described, and then a further heating takes place. Sometimes the process is lengthened in order to separate the silver—always present in lesser or greater proportion—from the lead. Silver is, however, found in such quantities in simpler form as to make it hardly worth while to separate it from lead, unless the lead ore be unusually rich in silver. We will bring our lesson to a close by enumerating the bodies that we have discussed:

Lead (L. *plumbum*), s.g. 11·3; m.p. 330° C.; soft, bluish-white, malleable, fairly ductile, easily fusible.

Litharge = lead oxide, PbO.

Red lead = lead oxide, Pb_3O_4.

Lead nitrate, $Pb(NO_3)_2$; Lead chloride, $PbCl_2$; Lead sulphate, $PbSO_4$.

White lead = basic lead carbonate.

THE SERIES METHOD OF LANGUAGE-TEACHING.

MANY of us have had sad experience of vaunted educational discoveries which have promised much, only to come far short in fulfilment. We are, therefore, perhaps more or less inclined to receive the rumour of a new method with some scepticism, loth to turn aside from the beaten track in which the results, poor and unsatisfactory though they may be, can at any rate be reckoned on with some degree of certainty. To learn and really learn a language in six months, or a year at the outside, and to do so as a pleasant relaxation rather than as an irksome study, seems at first sight a wonder too good to be true. Any reader of this article, however, has it in his power to convince himself, if he chooses, that the Series Method is able to make good its claim to provide us not only with a royal road, but even with a short cut to the acquisition of a foreign tongue, and

that those who advocate its use are educationalists able to give an intelligent account of the lines on which they proceed, and adduce scientific reasons for the results they have it in their power to attain.

It is needless to descant on the general discontent with the system of language-teaching now in vogue, and the little it can effect after years of wearisome study. The usual method is stamped at once with the word 'impractical,' since students who have spent months and even years in the acquisition of French and German, might as well have been employed in the study of dead languages for any practical or colloquial use they are able to make of their hard won knowledge. Set down in a foreign country they find themselves quite unable to carry on the most elementary conversation, or to transact the simplest business of every-day life, even such as sending a telegram or asking the time of a train.

It is obvious that the learning of disconnected sentences such as—'You have the brother's sister's letter,' 'Have we the horse's hay?' will not interest students in the language, help them to read its literature, or enable them to ask for what they want in a foreign country. And yet such are the phrases that are actually offered to the public by a recent paper that claims the name of 'Popular Educator,' and promises to teach languages without a master, 'so that any tourist may obtain, in a reasonably short space of time, sufficient knowledge of the language to know something of the life of the people in the country in which he is intending to travel.'

To learn nonsense phrases and the mere dead forms of grammar apart from the sentence, is so much futile toil, which leaves the student quite incapable of understanding the living tongue when he hears it around him, and hours of hard grinding at dictionary and vocabulary make him the slave rather than the master of words he is powerless to command.

Thought goes before speech, and such a student is unable to express himself in the new language with any fluency, for the reason that he is unable to think in it, but must, by a painful process, mentally translate from one language into the other. The Series Method, which is now becoming widely used in England, has proved itself really able to make the students, and from the first, think in the language studied.

Although it will always be granted that the theory that the student should learn to *speak* the foreign language is ideally correct, it may possibly be argued, in certain cases, that under the modern pressure of examinations (which the teacher is forced to consider) he is obliged to pay first attention to those details of grammar that the student is ordinarily expected to know. He will say that 'It is all very well to talk of the dull drudgery of ordinary lessons; but that drudgery is an absolute necessity if pupils are not to fail by the ordinary tests.' Pedagogic science has now sufficiently advanced, however, for it to be generally admitted that the dry bones of grammar, verbs, and declensions are not best acquired on the plan of learning by heart, but that they will be more quickly and easily assimilated in the course of learning to speak if a right method be adopted.

The same thing may be said with regard to the idioms of a language, which can never be taught from books alone or by any mere process of translation, but are only to be thoroughly grasped when they are seen to have an appreciable value as the apt expression of certain thoughts. The commonest idiomatic phrases are not likely to be remembered and used in their true application when learned amid a jumble of dissimilar sentences, but will not be misapplied when they have been heard as living phrases in actual conversation.

Froebel and other educationalists based their theories on their observation of natural phenomena, and strove to draw out the power of the child-mind by obedience to the laws by which it is governed. The Series Method has as good a ground for its claims to follow true principles of psychology. Of course it goes without saying that no system can be 'natural' in the instructive and spontaneous sense of the word, but only in so far as it bases its operations on those of Nature, the great teacher. The Series Method, working on psychological lines, strives to put the student of a foreign language in much the same position as that of the person who is learning to speak his native tongue, and to provide him in class, in a certain organised way, with much the same material as that which the native unconsciously appropriates and makes his own.

When we attempt to learn a language on the old plan we concentrate our whole attention on the written words; we copy them, spell them, learn them off by heart, and although we try to use them in sentences of our own, do so by a slow and difficult method of mental translation, which leaves us quite helpless so far as correct idiomatic and fluent speech is concerned. The words and phrases of our grammar and dictionary are so many dead forms, black marks on paper, unrelated to any conceptions, sufficiently vivid to stamp themselves upon our memories even when we plod patiently on this track for years. But let us ask this question, Does the child who picks up his own language (which is to him for all practical purposes a foreign tongue), in a fraction of the time we spend at school, go to work in a like manner? The question seems absurd, and we should think a woman mad who attempted to teach her child grammar and spelling before it could speak, though it takes us some time to realise our own folly in reversing the natural order of things at school, and relegating actual speech to the possibilities of some dim future. Is it right pedagogic science so completely to reverse the apparently natural order?

What is it to learn a language? It is to associate certain 'sounds' with the 'concepts' to which they belong. Many concepts, in fact nearly all that the child can learn at an early stage, are concrete and can be visualised, that is, reproduced in imagination, or seen as vividly realised pictures in the mind's eye.

To make this clear, we will imagine that we are about to give a little child quite a new experience. If he has lived inland, the words 'sea,' 'shore,' sand,' rock,' etc., are mere sounds to him, conveying no real meaning. Let him realise, himself, what the ocean is like, let him play with the sand, clamber on the rocks, and feel the wash of the waves on his feet, and for ever afterwards the sounds of the new words and phrases which are linked to each of the facts of his fresh experience will call up a distinct set of mental pictures, which he will most likely, if properly encouraged, try to turn into actual pictures with paper and pencil. Every phrase he learns therefore in the whole course of learning to speak is associated with things actually seen, which he can reproduce in his imagination, or of things made so vivid to him by pictures and descriptions that he has the power to form an image of them in his mind's eye. His progress therefore is always on concrete lines, and by linking sounds to sights.

On the Series Method the attempt is therefore made to lead the student from the first to think or visualise in the new language—a process, it will be seen, at absolute variance with the usual mode of procedure.

It is found that the student who has not been subjected to the stultifying ordeal of ordinary language-teaching can learn to do this easily for a foreign tongue, with the help of a well-trained teacher who is able, by voice and gesture, to make him picture in his mind's eye the action which he is learning to express in the new language. The pupil, child or adult, who has been taught on the old plan to attach immense importance to the written word, may at first find some difficulty in freeing himself from this bad habit, and in concentrating all his attention upon the mental picture that the word should call up, rather than on the letters of the word itself. This, however, can be done, and so successfully, that in a few weeks from the beginning the whole lesson can be carried on and the explanations given in the language which is being imparted.

The first point, therefore, of the Series Method, is to use that most efficient instrument provided by the student himself—the imagination, the visualising faculty which everyone possesses; the second is to provide that faculty with material on which to work, since no one can be expected to evince keen, imaginative interest in the senseless jumble of the French grammar, or to employ his visualising faculty on insipid sentences concerning the moral excellencies of hypothetical mothers and aunts, stale statements with regard to the 'wall of Balbus,' or dull reiterations concerning the gardener's pen. What, then, is the material that the Series Method employs?

Turn to any dictionary, and you will find that the words may be roughly classified thus:—(1) rare, obsolete, or technical words, (2) words used by the average adult, (3) a yet smaller number known to the fairly educated youth of fourteen. Among these latter we shall find the majority of words most intimately connected with the needs and uses of every-day existence, and they will therefore make up the essential part of the language which should be taught first. It may be subdivided into two divisions—first, of words belonging to the external facts of life, objective words; secondly, of words which express emotions or states of mind, subjective words. Of the first division, it is easy to see that certain of the words naturally belong together, falling into groups in which they are inter-related. The group in the house (toilet, meals, etc.), the group of the farm, the shepherd, the fisherman: of the dog, the bee: of a journey of sickness or death. In the series such groups of words are, moreover, arranged in sentences which follow the connected and natural sequence of the events they describe, and the pupil, in learning to speak them, lives through, as it were, in imagination, all the actions which they express, learning to explain in the foreign tongue what the blacksmith does in his forge, or the sailor in his ship; now taking an imaginative journey, complete in all its details; now being provided with some scene of the harvest, the mill, the law-court, or shop, complete in all the appropriate expressions.

So much for the objective phrases which are arranged in 'series,' each number of which deals with a particular sequence of actions which it is possible to express in the ordinary language of life.

for your discrimination you shall work the next experiment. Take another spoon. Place some litharge in it, and hold the spoon over the bunsen whilst Ernest shall blow under the spoon with his blowpipe in order to get a sufficiency of heat. It is changing from yellow to red, sir. Quite correct. But what is Annie so eager about? Is that red lead, sir? Yes; and you know who uses that, I suppose? My father, who is a painter, sir, uses both red lead and white lead to mix with his paints. Very true. Red lead is a pigment. It is called *minion*, and because portraits used to be painted with this pigment, called for this reason miniatures, this word is now used for a diminutive portrait; of course it really means, made of minion. But to our work. To what class of bodies does red lead belong, Willie? It is an oxide of lead, sir, but I should have thought that heating the litharge would have driven out the oxygen. On the contrary, it causes more oxygen to enter into combination, for red lead is Pb_3O_4, so that whereas in litharge there are three atoms of O to every three of lead, in minion there are four of oxygen to every three of lead.

For our next experiment we require some powdered charcoal, with which we mix a quantity of litharge and heat them together. What would you expect to happen under these circumstances, Tom? The carbon would combine with the oxygen of the litharge and leave the lead behind. Try it, and tell us when you have done whether or no this is so. Here is the lead, sir, so my answer, I suppose, was correct. Yes; and you will remember that carbon is extremely useful in this way to reduce metals from their ores. It is now for you to perform an experiment. Into this test-tube place some litharge, to which add dilute nitric acid and apply heat. Tell us what happens. The litharge dissolves, sir, and leaves a clear solution. Good. Now pour out the liquid into your evaporating dish and again heat until you see some crystals appear. What do you think those crystals are? Well, let Bob tell us, as you cannot. They are crystals of lead nitrate, sir. You have formed a salt by bringing together a base (PbO) and an acid. Very nicely answered; and now let us see what happens when we use the metal in place of the oxide. Well, Fred, what have you noted? The lead is dissolved, sir. What is formed? Lead nitrate, I suppose. Yes; so that you have prepared the nitrate in two distinct ways. Make a solution of the nitrate from the bottle in the cupboard, and to this solution add some hydrochloric acid. What is the white stuff that is produced like? It is just like curded milk, sir. Very true; and now what shall we call it? You answer, Tom. It is lead chloride, sir. Quite right; and as this sort of action is very common, I will put down the equation representing it on the board:

$$Pb(NO_3)_2 + 2\,HCl = PbCl_2 + 2\,HNO_3.$$

Lead nitrate & hydrochloric acid yield lead chloride & nitric acid.

We call this action *double decomposition*, because each body breaks up into two parts, and the two parts of one combine with the two parts of the other to form two new substances. Now, Tom, how could you form lead sulphate? By adding sulphuric acid to lead nitrate. Yes; just as in the former case, double decomposition would ensue. Place some lead in water for me, Charlie. Does it dissolve? No, sir. Quite so. Do we ever put water in lead vessels? Think a minute. Ah! I see what you mean, sir; you mean the lead water-pipes. Yes; and when I tell you that lead compounds are generally very poisonous, you will see how important this question is. Well, Annie, what is it? Please, sir, is it from lead poisoning that painters suffer when they have painter's colic? It is, and a very dreadful disease it is. Moreover, it would be very much better if we could do without leaden water-pipes, for although pure water does not act on pure lead, that does not make us safe, for the lead of pipes is rarely pure, and water, as you know, is never pure. You would, I am sure, like to know what to do if ever you should have to deal with a case of lead poisoning, so I will proceed to tell you. If a substance be insoluble in water or the digestive juices it cannot poison. Hence the thing to do when poison has been taken is to find a substance that will render the poison powerless by making it insoluble. Now the sulphate of lead that you made just now is exceedingly insoluble. Suppose, then, that some sugar of lead (which is lead acetate) has been swallowed. If this is followed up by some Epsom salts, which is magnesium sulphate, double decomposition takes place, and from lead acetate and magnesium sulphate you get magnesium acetate and harmless (because insoluble) lead sulphate. I will give you the equation, in order to further impress this upon your memory:

$$Pb(C_2H_3O_2)_2 + MgSO_4 = PbSO_4 + Mg(C_2H_3O_2)_2.$$

Lead acetate & magnesium sulphate yield lead sulphate & magnesium acetate.

What is your question, Frank? Please, sir, what is white lead? Your question just comes at the right time. We have spoken about the nitrate, the chloride, and the sulphate of lead, and now you lead up to the carbonate, or rather *a* carbonate, for white lead is a peculiar carbonate of lead known as a basic carbonate. You will remember that we said a salt is produced when an acid is neutralised by a base. In some cases, even after the acid has been neutralised, a further portion of the base can be added to the compound, when we get a *basic salt* such as basic lead carbonate. Compare the two formulæ that I am putting on the board and you will understand what I mean:

$PbCO_3$ = lead carbonate.

$(PbCO_3)_2, Pb(OH)_2$ = basic lead carbonate.

You need not trouble much about this, as it is somewhat in advance of your work; still it is interesting, especially as we could not finish our lesson without mentioning such a highly important body as white lead. Look once again at my specimens. What does this look like? It looks like lead, sir. Get a hard glass test-tube out, Lily, and we will see if we can find anything else besides lead. That is right. Incline the tube and heat the contained substance. Now smell. It is just like the smell of burning matches. Yes, but you can do better than that. What is it that gives such a suffocating odour when matches burn? Is it the sulphur, sir? You are not far out; it is the burning sulphur, or rather the body that results from the burning of the sulphur; and pray what is that, Lily? It is sulphur dioxide. Just so, and in this case the oxygen comes from the air and the sulphur from the lead-like substance. If this consists of lead and sulphur, it will be what, Charlie? Lead sulphide, sir. Exactly. This is the commonest ore of sulphur, and is called *galena*. To prepare lead for galena the ore is first roasted in the way described, and then a further heating takes place. Sometimes the process is lengthened in order to separate the silver—always present in lesser or greater proportion—from the lead. Silver is, however, found in such quantities in simpler form as to make it hardly worth while to separate it from lead, unless the lead ore be unusually rich in silver. We will bring our lesson to a close by enumerating the bodies that we have discussed:

Lead (L. *plumbum*), s.g. 11·3; m.p. 330° C.; soft, bluish-white, malleable, fairly ductile, easily fusible.

Litharge = lead oxide, PbO.

Red lead = lead oxide, Pb_3O_4.

Lead nitrate, $Pb(NO_3)_2$; Lead chloride, $PbCl_2$; Lead sulphate, $PbSO_4$.

White lead = basic lead carbonate.

THE SERIES METHOD OF LANGUAGE-TEACHING.

MANY of us have had sad experience of vaunted educational discoveries which have promised much, only to come far short in fulfilment. We are, therefore, perhaps more or less inclined to receive the rumour of a new method with some scepticism, loth to turn aside from the beaten track in which the results, poor and unsatisfactory though they may be, can at any rate be reckoned on with some degree of certainty. To learn and really learn a language in six months, or a year at the outside, and to do so as a pleasant relaxation rather than as an irksome study, seems at first sight a wonder too good to be true. Any reader of this article, however, has it in his power to convince himself, if he chooses, that the Series Method is able to make good its claim to provide us not only with a royal road, but even with a short cut to the acquisition of a foreign tongue, and

that those who advocate its use are educationalists able to give an intelligent account of the lines on which they proceed, and adduce scientific reasons for the results they have it in their power to attain.

It is needless to descant on the general discontent with the system of language-teaching now in vogue, and the little it can effect after years of wearisome study. The usual method is stamped at once with the word 'impractical,' since students who have spent months and even years in the acquisition of French and German, might as well have been employed in the study of dead languages for any practical or colloquial use they are able to make of their hard won knowledge. Set down in a foreign country they find themselves quite unable to carry on the most elementary conversation, or to transact the simplest business of every-day life, even such as sending a telegram or asking the time of a train.

It is obvious that the learning of disconnected sentences such as—'You have the brother's sister's letter,' 'Have we the horse's hay?' will not interest students in the language, help them to read its literature, or enable them to ask for what they want in a foreign country. And yet such are the phrases that are actually offered to the public by a recent paper that claims the name of 'Popular Educator,' and promises to teach languages without a master, 'so that any tourist may obtain, in a reasonably short space of time, sufficient knowledge of the language to know something of the life of the people in the country in which he is intending to travel.'

To learn nonsense phrases and the mere dead forms of grammar apart from the sentence, is so much futile toil, which leaves the student quite incapable of understanding the living tongue when he hears it around him, and hours of hard grinding at dictionary and vocabulary make him the slave rather than the master of words he is powerless to command.

Thought goes before speech, and such a student is unable to express himself in the new language with any fluency, for the reason that he is unable to think in it, but must, by a painful process, mentally translate from one language into the other. The Series Method, which is now becoming widely used in England, has proved itself really able to make the students, and from the first, think in the language studied.

Although it will always be granted that the theory that the student should learn to *speak* the foreign language is ideally correct, it may possibly be argued, in certain cases, that under the modern pressure of examinations (which the teacher is forced to consider) he is obliged to pay first attention to those details of grammar that the student is ordinarily expected to know. He will say that 'It is all very well to talk of the dull drudgery of ordinary lessons; but that drudgery is an absolute necessity if pupils are not to fail by the ordinary tests.' Pedagogic science has now sufficiently advanced, however, for it to be generally admitted that the dry bones of grammar, verbs, and declensions are not best acquired on the plan of learning by heart, but that they will be more quickly and easily assimilated in the course of learning to speak if a right method be adopted.

The same thing may be said with regard to the idioms of a language, which can never be taught from books alone or by any mere process of translation, but are only to be thoroughly grasped when they are seen to have an appreciable value as the apt expression of certain thoughts. The commonest idiomatic phrases are not likely to be remembered and used in their true application when learned amid a jumble of dissimilar sentences, but will not be misapplied when they have been heard as living phrases in actual conversation.

Froebel and other educationalists based their theories on their observation of natural phenomena, and strove to draw out the power of the child-mind by obedience to the laws by which it is governed. The Series Method has as good a ground for its claims to follow true principles of psychology. Of course it goes without saying that no system can be 'natural' in the instructive and spontaneous sense of the word, but only in so far as it bases its operations on those of Nature, the great teacher. The Series Method, working on psychological lines, strives to put the student of a foreign language in much the same position as that of the person who is learning to speak his native tongue, and to provide him in class, in a certain organised way, with much the same material as that which the native unconsciously appropriates and makes his own.

When we attempt to learn a language on the old plan we concentrate our whole attention on the written words; we copy them, spell them, learn them off by heart, and although we try to use them in sentences of our own, do so by a slow and difficult method of mental translation, which leaves us quite helpless so far as correct idiomatic and fluent speech is concerned. The words and phrases of our grammar and dictionary are so many dead forms, black marks on paper, unrelated to any conceptions, sufficiently vivid to stamp themselves upon our memories even when we plod patiently on this track for years. But let us ask this question, Does the child who picks up his own language (which is to him for all practical purposes a foreign tongue), in a fraction of the time we spend at school, go to work in a like manner? The question seems absurd, and we should think a woman mad who attempted to teach her child grammar and spelling before it could speak, though it takes us some time to realise our own folly in reversing the natural order of things at school, and relegating actual speech to the possibilities of some dim future. Is it right pedagogic science so completely to reverse the apparently natural order?

What is it to learn a language? It is to associate certain 'sounds' with the 'concepts' to which they belong. Many concepts, in fact nearly all that the child can learn at an early stage, are concrete and can be visualised, that is, reproduced in imagination, or seen as vividly realised pictures in the mind's eye.

To make this clear, we will imagine that we are about to give a little child quite a new experience. If he has lived inland, the words 'sea,' 'shore,' sand,' rock,' etc., are mere sounds to him, conveying no real meaning. Let him realise, himself, what the ocean is like, let him play with the sand, clamber on the rocks, and feel the wash of the waves on his feet, and for ever afterwards the sounds of the new words and phrases which are linked to each of the facts of his fresh experience will call up a distinct set of mental pictures, which he will most likely, if properly encouraged, try to turn into actual pictures with paper and pencil. Every phrase he learns therefore in the whole course of learning to speak is associated with things actually seen, which he can reproduce in his imagination, or of things made so vivid to him by pictures and descriptions that he has the power to form an image of them in his mind's eye. His progress therefore is always on concrete lines, and by linking sounds to sights.

On the Series Method the attempt is therefore made to lead the student from the first to think or visualise in the new language—a process, it will be seen, at absolute variance with the usual mode of procedure.

It is found that the student who has not been subjected to the stultifying ordeal of ordinary language-teaching can learn to do this easily for a foreign tongue, with the help of a well-trained teacher who is able, by voice and gesture, to make him picture in his mind's eye the action which he is learning to express in the new language. The pupil, child or adult, who has been taught on the old plan to attach immense importance to the written word, may at first find some difficulty in freeing himself from this bad habit, and in concentrating all his attention upon the mental picture that the word should call up, rather than on the letters of the word itself. This, however, can be done, and so successfully, that in a few weeks from the beginning the whole lesson can be carried on and the explanations given in the language which is being imparted.

The first point, therefore, of the Series Method, is to use that most efficient instrument provided by the student himself—the imagination, the visualising faculty which everyone possesses; the second is to provide that faculty with material on which to work, since no one can be expected to evince keen, imaginative interest in the senseless jumble of the French grammar, or to employ his visualising faculty on insipid sentences concerning the moral excellencies of hypothetical mothers and aunts, stale statements with regard to the 'wall of Balbus,' or dull reiterations concerning the gardener's pen. What, then, is the material that the Series Method employs?

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So much for the objective phrases which are arranged in 'series,' each number of which deals with a particular sequence of actions which it is possible to express in the ordinary language of life.

The subjective words—words of inner personal feeling—are arranged also in phrases and repeated in rehearsed conversations in class till they are thoroughly assimilated.

Anyone who cares to further study the system will find that its claims are not exaggerated; that it rests on a firm basis of true psychological principles, and in the hands of qualified teachers, may be made to yield results which a long acquaintance with unscientific methods inclines one, on a first hearing, to think almost miraculous. It is already adopted in many leading schools, and is being taken up by an increasing number of teachers, while educationalists come to investigate it from the continent and America.

The home of the Method in London is at Howard House, Arundel Street, Strand, where classes for both pupils and teachers are constantly carried on by the teachers on the Method, who are further applying some of its principles to the teaching of Literature, Mathematics, History, Geography, and other subjects, as well as to foreign and classical languages.

EXERCISES IN FRENCH FOR CERTIFICATE EXAMINATION.

This month we bring to a close this course of exercises intended to prepare students for the French paper in the forthcoming Certificate Examination. The sight-tests have been taken from good authors widely differing in style, and include an extensive vocabulary. Almost every important rule of syntax that is likely to present difficulty to the English student has been explained and illustrated, in some cases, as must be done in successful teaching, over and over again. Students who have followed this course systematically cannot fail to write a good French paper. Their best preparation for the general part of their examination will be a careful revision of the rules and illustrations which have appeared under the above heading in the 'PRACTICAL TEACHER' in the months from April to December inclusive. We both wish and ensure our careful readers success.

A.—NOTES ON FRENCH-ENGLISH SIGHT-TESTS.

The following are notes on, and translations of, the italicised passages in the French-English sight-tests set in the November number of the 'PRACTICAL TEACHER,' to which the student is referred for the context:—

I.—*First Year Students.*

(i.) *Chacun alla s'emparer d'une maison.* Each one went and seized on a house.

Note: (*a*) *Chacun* is a pronoun, *chaque* an adjective. (*b*) *s'emparer de* = to seize on, to take possession of.

(ii.) *Rien ne put la décider à renoncer à ce projet* = Nothing could induce her to renounce this project.

Note that *renoncer* is intransitive, and requires *à* with its complement.

Que nous allions visiter = which we were about to visit.

Note that *aller* is used to denote immediate futurity, and is one of those verbs that take no preposition before the infinitive complement.

(iii.) *Le moulin n'est pas achevé de bâtir* = The mill is not finished building.

Que faire? = What am I to do?

Note this exclamatory use of the interrogative pronoun and infinitive. Observe that no answer is expected to such questions.

Ce moulin, mes paysans ne peuvent s'en passer = As for this mill, my peasants cannot do without it.

Note: Se passer de = to do without, to dispense with; the *de* with its pronoun object *il* (*i.e.*, *le*) is expressed by *en*.

Il me faudra même de l'économie = I shall even have to practise economy (*lit.*, there will be necessary to me even some economy).

Est-il possible qu'avec 80,000 *livres de rente, on ne puisse pas se tirer d'affaire* = Is it possible that with an income of 80,000 pounds, one cannot get out of difficulties.

Note: (*a*) *rente* = revenue, income, stock (investment); (*b*) *puisse* is subjunctive because following the impersonal phrase interrogative, '*est-il possible?*'; (*c*) *se tirer d'affaire* is an idiom meaning to extricate oneself from difficulties.

(iv.) *Souverains venus avec leurs usages* = Sovereigns who had come bringing with them their customs.

Note: Why is *venus* plural? Because it conjugates with *être*, and the participle agrees with the subject, or, if the subject be understood, with the antecedent of the relative pronoun subject.

II.—*Second Year Students.*

(i.) *Parce que la colonne eût été arrêtée* = Because the column (or *main army*) would have been stopped.

Note (*a*) that the conditional perfect *aurait été* would have been equally correct. (*b*) Why is *arrêtée* feminine?

(ii.) *Prétendant le rendre responsable* = Pretending to make (or *hold*) him responsible.

Note: Why *rendre* here? Always use *rendre* (not *faire*) to translate the English *make* when followed by a factitive adjective.

J'avais peine à me rendre compte des angoisses = I had difficulty (or *I found it difficult*) to account for the distress of mind.

Note: compte is a noun, and *me* is the dative reflexive pronoun.

(iii.) *Là toutes les distinctions de sexe ont achevé de disparaître* = There all distinctions of sex have completely disappeared (*lit.*, *have finished disappearing*).

Ce qu'il y a de plus élevé = What there is that is ennobling.

Note the *de* before the adjective *élevé;* this is always inserted before an adjective following and qualifying an indefinite pronoun, such as *ce que, rien, quelque chose.*

(iv.) *Que de choses je vais faire dans ma journée* = How many things I shall do in the day before me.

Note: (*a*) *Que* is the *exclamatory* adverb of quantity, hence *de* after it according to rule; (*b*) *vais faire* instead of *ferai*, as the future referred to is immediate; (*c*) that *journée* does NOT mean *journey.*

Matière d'une feuille d'impression = my contribution to his journal. (This cannot be translated literally.)

Mais j'ai du temps = *Why!* I have plenty of time.

Il fait beau = It is fine (weather). Cf. *il fait sombre* = it is dull; *il fait du soleil* = it is sunshiny, etc.

Enfin m'y voilà = At last here I am.

Demandez-moi ce qu'est devenue ma journée = Ask me what has become of my day.

Compare *Qu'est-il devenu?* = What has become of him? with *Il s'est fait soldat* = He has become a soldier.

Note that where the *becoming* is a *voluntary* act, *se faire* is used to translate our *become.*

B.—TRANSLATION OF ENGLISH-FRENCH SIGHT-TESTS.

The following are translations of, and notes on, the passages set for translation into French in the November number of the 'PRACTICAL TEACHER.'

I.—*First Year Students.*

(i.) Quelques mois plus tard, ce prince infortuné, à la sollicitation de la reine Isabeau, *lui* accorda en mariage la princesse Catherine, sa fille, avec la promesse qu'après sa mort, il réunirait cette couronne à *celle* d'Angleterre, et se trouverait ainsi *l'un* des plus puissants monarques *du* monde.

Note: (*a*) The English habit of using the dative object without a preposition leads students to frequently employ *accusative* forms instead of *dative. Lui* is dative governed by *accorda.* (*b*) The *l'* before *un* is euphonic. (*c*) *Celle* must not take the enclitic particle *là* (celle-là) when followed by a complement (*d'Angleterre* in this case). (*d*) The *in* following a superlative adjective in English must be translated by *de.* 'Elle est la première élève *de* sa classe.'

(ii.) Le fils de Henri V. n'était qu'un tout petit enfant, lorsqu'il fut proclamé roi de France et d'Angleterre, sous le nom de Henri VI.; mais, *comme cela s'est vu* bien souvent, cet enfant, qui paraissait appelé à une si haute destinée, n'eut au contraire que la vie la plus misérable et la plus infortunée.

Note that the passive phrase *as has often been seen* is translated by the reflexive verb *se voir*, and that reflexive verbs always conjugate with *être.*

(iii.) Pendant cette querelle sanglante, le malheureux Henri, *tantôt* au pouvoir des amis de Lancastre, *tantôt* entre les mains du duc d'York, était le misérable jouet du sort des armes; et quoique Richard *affectât* encore de le traiter avec respect, il *n'en était pas moins* son prisonnier.

Note: (*a*) The correlative words *now . . . now, at one time . . . at another time,* are translated by *tantôt . . . tantôt.* (*b*) That *quoique* is invariably followed by the subjunctive. (*c*) *On that account* is translated by *en* when it is used with such phrases as *the more, the less.* (*d*) That the adverbial *the* before comparatives is not translated in French. *E.g.*, '*Plus on est jeune, plus on est heureux*' = 'the younger one is, the happier he is.'

(iv.) Clifford ayant demandé au jeune fuyard *quel* était son nom, le pauvre enfant, tout tremblant, se jeta à ses pieds en pleurant, et lui avoua qu'il était *l'un* des fils de Richard. 'S'il en *est* ainsi,' repartit aussitôt cet homme féroce, 'comme ton père a causé la mort du mien, je *veux* aussi te *tuer*, toi et tous tes frères.' En disant ces

mots, l'impitoyable Clifford tira son poignard, et le plongea tout entier dans le cœur de l'enfant qui expira sur-le-champ.

Note (*a*) the idiom for 'if that is so,' and that *si* = *if*, is never followed by the subjunctive except in one tense, viz., subjunctive pluperfect; (*b*) that *vouloir with the infinitive* is used instead of the *future tense*, when the word *will* in English is emphatic, and expressing determination.

II.—*Second Year Students.*

(i.) Ces trois misérables, à qui Richard avait remis pour cette nuit la clef de la prison des jeunes princes, les trouvèrent *couchés* sur le même lit, et profondément *endormis* dans les bras l'un de l'autre. Un livre de prières était ouvert à côté d'eux; car malgré leur jeune âge, ils n'avaient point oublié que leur mère avait recommandé de ne jamais s'endormir sans avoir prié Dieu de bénir leur sommeil. Ils étaient si beaux, et leur visage était si paisible, que Tyrrel et ses complices, tout scélérats qu'ils étaient, ne purent s'empêcher d'être *touchés* de leur innocence.

Note (*a*) the participles; see that you have made them agree with the words qualified. (*b*) Observe the concessive use of the adverb *tout* before *scélérats*. (The phrase equals 'although they were such scoundrels.') (*c*) Be careful how you translate 'help' = avoid, or refrain from. *E.g.*, 'I could not help laughing' = '*je ne pus m'empêcher de rire.*' 'I can't help it' = '*je n'y puis rien*,' or '*je n'y puis mais.*' 'How can I help it?' = *Que voulez-vous que j'y fasse?*'

(ii.) Richard apprit bientôt le débarquement de son ennemi; et, *quoiqu'il sût* bien que les Anglais le haïssaient mortellement, il ne douta pas que s'il parvenait à vaincre Richmond, personne n'oserait plus désormais *lui disputer sa couronne*. Il se mit donc en marche à la tête d'une armée beaucoup plus nombreuse que celle de Tudor, et les deux adversaires *ne tardèrent pas* à se trouver en présence, auprès d'une petite ville nommée Bosworth, peu distante de Leicester, où une bataille parut inévitable.

Note: (*a*) The French say, 'dispute the crown to him.' (*b*) Observe the two idiomatic expressions, '*Il me tarde de commencer*' = 'I long to begin.' (Here *il* is impersonal.) 'Il tarde à venir,' 'He is a long time coming.' (Here, of course, *il* is personal.)

(iii.) A cette époque, les lords anglais avaient beaucoup perdu de l'humeur turbulente et guerrière de leurs aïeux les barons normands. La longue querelle des Deux Roses avait éteint ou dispersé la plupart des plus illustres familles, et beaucoup d'entre elles avaient vu leurs châteaux démolis pendant les guerres civiles. D'un autre côté, les bourgeois des villes, appelés pour la première fois dans les conseils des rois par Simon de Montfort, et souvent consultés par le puissant Edouard III., comme *je vous l'ai fait remarquer*, formaient dans les parlements une assemblée respectable et distincte de celle des lords, *à laquelle* on donnait le nom de Chambre des Communes.

Note (*a*) the translation of 'as I have had you observe.' When *had* has thus the meaning of *make* or *cause* it must be translated by *faire*, which never takes a *passive* infinitive after it; the agent of the action expressed by this infinitive, when transitive, is in the dative case. Thus *l'* is the object of *remarquer* and *vous* is the *dative of agent*. Compare '*Je l'ai fait partir*' = 'I have made him depart' (intransitive) with '*Je lui ai fait lire* (transitive) *ce livre*' = 'I have made (or *had*) him read this book.'

(*b*) When there are several words that might be taken as the antecedent of the relative, one of the various forms of *auquel* is generally used, as this may show by its number and gender which word is the antecedent; *e.g.*, *à qui* above would naturally refer to *lords*, but *à laquelle* must refer to an antecedent feminine singular; hence *assemblée* must be the antecedent.

Correction of Incorrect Sentences.

I. (*a*) *Incorrect:* 'Mon frère, mon cousin, et moi, iront en la campagne la semaine suivante.'

Corrected: 'Mon frère, mon cousin et moi *nous irons à* la campagne la semaine *prochaine*.'

Reasons: (*a*) The three nominatives of different persons must be summed up in one pronoun, the first person taking preference to the second, and the second to the third if there is no first person. Thus we insert *nous*. (*b*) The verb, when it has a compound nominative of different persons, agrees with the first person rather than the second, and the second rather than the third. (*c*) *à la campagne* = in the country. (*d*) The *coming* week or '*next* week' must be expressed by *prochaine*.

(*b*) *Incorrect:* 'L'un ou l'autre ont raison.'

Corrected: 'Ou l'un ou l'autre *a* raison.'

Reason: Only *one* is right; therefore the verb must be singular.

(*c*) *Incorrect:* 'Beaucoup de personnes croit cet histoire.'

Corrected: 'Bien des gens croient (or ajoutent foi à) cette histoire.'

Reasons: 'Beaucoup de personnes' might stand, but *gens* is a more indefinite word and more suitable here. *Croient* is necessary because the subject 'beaucoup de personnes' is plural. *Histoire* is feminine, hence *cette* is necessary.

(*d*) *Incorrect:* 'Les colonnes du temple étaient en marbre très dures.'

Corrected: 'Les colonnes du temple étaient de marbre très dur.'

Reason: The *marble*, not the columns, was hard.

(*e*) *Incorrect:* 'Disez à vôtres amies de venir et de dîner avec mon frère et me cette soirée.'

Corrected: 'Dites à vos amies de venir dîner ce soir avec mon frère et moi.'

Reasons: (*a*) *Dire*, *faire*, and *être* have their 2nd plural present indicative forms ending in *es*—dites, faites, êtes. (*b*) *Vôtres* is a pronoun, never an adjective. 'Ces livres sont les vôtres.' (*c*) *venir* and *aller* take an infinitive without a preposition after them to translate our '*come and do*,' '*go and do*.' (*d*) *me* is *conjunctive*, *i.e.*, used with verbs; *moi* is *disjunctive*, and must always be used after a preposition. (*e*) *Soirée* denotes too extended a period to be suitable here.

(*f*) *Incorrect:* 'Votre frère est plus grand que j'aie cru.'

Corrected: 'Votre frère est plus grand que je n'ai cru (or *que je ne l'ai cru*).'

Reasons: When the subordinate adverbial sentence following a comparative is *affirmative*, an untranslatable negative is used in French, and the verb is in the *indicative* (not *subjunctive* as in the above sentence).

(*g*) *Incorrect:* 'Voilà les plus grands chevaux que j'ai vu.'

Corrected: 'Voilà les plus grands chevaux que j'aie vus.'

Reasons: (*a*) the adjective sentence, qualifying a noun that is qualified by an adjective in the superlative degree, requires the subjunctive; *e.g.*, *que* refers to chevaux, chevaux is qualified by *les plus grands*, an adjective in the superlative degree; therefore the sentence introduced by *que* has the verb in the subjunctive. (*b*) *vus* must be plural because conjugated with *avoir*, and having its direct object *que* (which agrees with chevaux) preceding it.

(*h*) *Incorrect:* 'Voici les montres qu'ils sont prêté l'un l'autre.'

Corrected: 'Voici les montres qu'ils se sont prêtées l'un à l'autre.'

Reasons: (*a*) *Se* is a reflexive, or rather here a reciprocal pronoun, and therefore the verb is a *pronominal* verb and conjugates with être; hence *sont* instead of *ont*. (*b*) *Se* = to one another, and is therefore the indirect object; consequently *prêté* the participle cannot agree with *se;* but *que*, the direct object of *prêtées*, precedes the verb, and hence *prêtées* agrees with *que* (which agrees with its antecedent *montres*). (*c*) *l'un l'autre* would be used if *se* were the direct object; but *l'un à l'autre* is used here as *se* is *dative* (or the indirect object).

II. Translate and explain the difference in the agreement of the past participles in the following sentences:—

(*a*) '*Nous nous sommes assurés de la vérité.*'

Translation: We have assured ourselves of the truth.

Explanation: The verb is *reflexive; nous* being the *accusative* reflexive pronoun, the participle agrees with this object *nous* in number and gender.

(*b*) '*Nous nous sommes assuré des revenus.*'

Translation: We have assured incomes to ourselves.

Explanation: The verb is reflexive, but *nous* is the *dative* reflexive pronoun; therefore, as no direct object precedes the verb, the participle is invariable.

(*c*) '*Elle s'est arrachée de nos bras.*'

Translation: She has torn herself from our arms.

Explanation: The verb is reflexive; *se* is the direct object, and therefore the participle agrees with it.

(*d*) '*Elle s'est arraché les cheveux.*'

Translation: She had torn out her hair.

Explanation: The verb is reflexive; *se* is the *dative* of possession denoting *to whom* the hair belongs; therefore the participle cannot agree with *se*, and, as no direct object precedes, the participle is invariable.

(*e*) '*Voici les chaises que nous avons fait raccommoder.*'

Translation: Here are the chairs we have had mended.

Explanation: Whenever *faire* is followed by a complementary infinitive, the participle of *faire* is invariable; this is because the direct object preceding it is really the object of the infinitive.

(*f*) '*Voici les chaises que nous avons faites.*'

Translation: Here are the chairs we have made.

Explanation: Here the verb *faire* conjugates with *avoir*, and its direct object precedes it; consequently *faites* is feminine plural in agreement with *que* (standing for *chaises*).

French-English Sight-Tests.

The following are a few tests by which students may try for themselves their own efficiency.

I.—*First Year Students.*

(i.) Louis XVI., promenant sur tous ceux qui l'entouraient un regard tranquille, prend l'arrêt des mains de Grouvelle, l'enferme dans sa poche, et lit à Garat une lettre dans laquelle il demandait à la convention trois jours pour se préparer à mourir, un confesseur pour l'assister dans ses derniers moments, la faculté de voir sa famille, et la permission pour elle de sortir de France. Garat prit la lettre, en promettant d'aller la remettre tout de suite à la convention. Le roi lui donna en même temps l'adresse de l'ecclésiastique dont il désirait recevoir les derniers secours.—(*Thiers.*)

(ii.) Deux officiers s'étaient établis dans un des bâtiments du Kremlin. De là, leur vue pouvait embrasser le nord et l'ouest de la ville. Vers minuit, une clarté extraordinaire les réveille. Ils regardent, et voient des flammes remplir des palais, dont elles illuminent d'abord et font bientôt écrouler l'élégante et noble architecture. Ils remarquent que le vent du nord chasse directement ces flammes sur le Kremlin, et s'inquiètant pour cette enceinte, où reposaient l'élite de l'armée et son chef.—(*Ségur.*)

(iii.) Bonaparte entre avec joie à l'École militaire. Dévoré du désir d'apprendre, et déjà pressé du besoin de parvenir, il se fait remarquer de ses maîtres par une application forte et soutenue. Il est, pour ainsi dire, le solitaire de l'école; ou, quand if se rapproche des autres élèves, leurs rapports avec lui sont d'une nature singulière. Ses égaux doivent se ployer à son caractère, dont la supériorité, quelquefois chagrine, et quelquefois exerce sur eux un empire absolu.—(*Norvins.*)

(iv.) Les deux rives de Meschacebé présentent le tableau le plus extraordinaire. Sur le bord occidental, des savanes se déroulent à perte de vue ; leurs flots de verdure, en s'éloignant, semblent monter dans l'azur du ciel, où ils s'évanouissent. On voit dans ces prairies sans bornes, errer à l'aventure des troupeaux de trois ou quatre mille buffles sauvages. Quelquefois un bison chargé d'années, fendant les flots à la nage, se vient coucher parmi de hautes herbes, dans une île du Meschacebé.—(*Chateaubriand.*)

II.—*Second Year Students.*

(i.) Nous longeâmes cette île, et le lendemain nous arrivâmes en face de sept montagnes de glace rangées comme un collier de perles au bord de la mer. De loin on ne distingue pas les parois escarpées de ces glaces éternelles ; on ne voit qu'un immense plateau qui, d'un côté, semble descendre jusqu'au niveau des vagues, et de l'autre monte graduellement et s'enfuit dans le lointain. De ce plateau éclatant de blancheur s'élèvent sept pics aigus aux flancs noirs, aux angles déchirés. A les voir ainsi isolés l'un de l'autre, debout dans l'espace, on croirait voir autant d'îles sortant d'un océan de neige.—(*Marmier.*)

(ii.) "Je vous dis que l'Angleterre n'a jamais été un royaume électif, qu'elle est depuis près de mille ans un royaume héréditaire. Faites-moi donc connaître par quelle autorité je suis appelé ici. Voilà M. le lieutenant-colonel Cobbett ; demandez-lui si ce n'est pas de force qu'il m'a emmené de l'île de Wight. Je soutiendrai autant que qui que ce soit ici les justes privilèges de la chambre des communes. Où sont les lords? Je ne vois pas ici de lords pour constituer un parlement. Il y faudrait aussi un roi. Est-ce là ce qu'on appelle amener le roi à son parlement?"—(*Guizot.*)

(iii.) Quelles sont brillantes, en effet, ces vingt premières années du gouvernement de Louis XIV. ! Un roi plein d'ardeur et d'espérance saisit lui-même ce sceptre qui, depuis Henri-le-Grand, n'avait été soutenu que par des favoris et des ministres. Son âme qu'on croirait subjuguée par la mollesse et les plaisirs, se déploie, s'affermit et s'éclaire, à mésure qu'il a besoin de régner. Il se montre vaillant, laborieux, ami de la justice et de la gloire ; quelque chose de généreux se mêle aux premiers calculs de sa politique. Il envoie des Français défendre la chrétienté contre les Turcs en Allemagne et dans l'île de Crète ; il est protecteur avant d'être conquérant ; et, lorsque l'ambition l'entraîne à la guerre ses armes heureuses et rapides paraissent justes à la France éblouie.—(*Villemain.*)

(iv.) Le duc de Montpensier, fils du roi, qui paraissait plus dominé encore que les autres par l'impatience d'un dénouement, s'attacha de plus près à son père, l'assiégea d'instances et de gestes presque impérieux pour l'engager à se rasseoir et à signer. Cette attitude, ces paroles, restèrent dans la mémoire des assistants comme une des plus douloureuses impressions de cette scène. La reine seule, dans ce tumulte et dans cet entraînement de conseils timides, conserva la grandeur, le sang-froid et la ésolution de son rang d'épouse, de mère et de reine. Après avoir combattu avec le maréchal la pensée d'une abdication précipitée, elle céda à la pression de la foule, elle se retira dans l'embrasure d'une fenêtre, d'où elle contemplait le roi avec l'indignation sur les lèvres et de grosses larmes dans les yeux.—(*Lamartine.*)

English-French Sight-Tests for December.

Students are recommended not to consult the dictionary till they are quite sure they have done all they can without it.

A.—*First Year Students.*

(i.) Queen Elizabeth, like all the princes of the House of Tudor, was endowed (*douer*) with great and noble qualities ; but her soul was imperious and vindictive, and the history of her reign, which lasted not less than forty-five years, will let you know better than I could tell you her excellences (*avantages*) and defects.

(ii.) The throne of Scotland was at that time occupied by a young and beautiful princess, named Marie Stuart, who happened (*se trouver*) to be, like her, a grand-daughter of Henry VII., by her mother Margaret, eldest (*aîné*) daughter of that monarch, who, as I have told you, had been married to James IV., King of Scotland.

(iii.) One day when (*que*) this princess, accompanied by a small (*peu nombreux*) retinue, was passing along (*traverser*), in (*en*) taking a walk, one of the paths (*allée*) of her gardens, a pool (*mare*) of water which lay (*se trouver*) in her path stopped her walk, and was about (*aller*) to oblige her to retrace (say *return on*) her steps, when a young lord, darting (*s'élancer*) forward immediately, unfastened (*détacher*) from his shoulders a superb sky-blue mantle braided (*broder*) with gold, and extended it in the middle of the water, in order that the Queen might (*pouvoir*) continue her way with (*à*) dry feet.

(iv.) Some years before, Christopher Columbus, that bold Genoese pilot whose courageous enterprise had long been regarded as the dream of a diseased mind, had reached the New World, which later received the name of America. The route he (*always insert the relative*) had opened up (*ouvrir*) was very soon followed by other navigators, drawn (*entrainer*) by the hope of making new discoveries, and the history of the prodigious voyages of these bold (*hardi*) adventurers will doubtless appear to you very interesting.

B.—*Second Year Students.*

(i.) Twenty years had already flown by (*s'écouler*), that Marie Stuart had been languishing in this captivity, and so long a misfortune had not yet been able to disarm the animosity of the implacable Elizabeth. During this long space of time, England had been the theatre of many events which saddened (*assombrir*) her story. This princess, although she had been consecrated (*sacrer*) by a Catholic bishop, and although, following the example of her predecessors, she had solemnly, in that ceremony, sworn to maintain that religion, had very soon formally re-established the Anglican *form of worship* (*culte*).

(ii.) Queen Elizabeth had never been married ; and although the Parliament had several times begged (*supplier*) her to choose a husband from among the lords of her kingdom or the foreign princes, and even among the Kings of Europe, some of whom had sought (*solliciter*) her hand, she had persistently (*constamment*) refused (*se refuser à*) because she had too much pride to ever submit (*reflexive*) to the wishes of a husband as a wife must do.

(iii.) The voyage of Drake round the world, and the foundation of the State of Virginia by Walter Raleigh, soon followed by that of several other states which reached (*atteindre*) a rapid development, are very remarkable events which you would do well not to forget. Those long and toilsome (*pénible*) navigations were the first of this kind ; and, although, since that epoch, they have been renewed many times by clever mariners of every country, these intrepid pilots must be reckoned among those who have contributed most to originate (*faire naître*) among the English the taste for (say *of*) distant enterprises, in which they have surpassed for a long time all the other nations of the world.

(iv.) This Catesby communicated (*faire part de*) this horrible design to several of his friends, dissatisfied like himself, among whom was an officer, named Guy Fawkes, who was an intrepid man and one capable of the most desperate undertakings. The conspirators (*conjuré*) only amounted to a dozen ; but they were so determined to succeed in their vengeance, that they resolved among themselves to dig secretly a mine beneath the old palace of Westminster, where the Parliament habitually held their sittings (*séance*), and agreed that, after having filled it with a great quantity of gunpowder, they would set fire thereto at the moment when the King and all his court should be (*se trouver*) in that assembly.

OUR PUPIL TEACHERS' COURSE.

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SCHEME OF WORK FOR THE MONTH.

A.—*English.*

(i.) *First Year.*

(*a*) Parts of speech and phrases of which the subject of a sentence may consist. See Daniel, pp. 127, 128; Beach, pp. 10–12, 125; Morris, pp. 109, 110.

(*b*) Division of subject into nominative and enlargement. See Daniel, pp. 128–131; Beach, p. 126; Morris, pp. 110, 111.

(ii.) *Second Year.*

Subordinate sentences; examples in analysis; comparison between Latin and English prefixes having (*a*) the same form, (*b*) the same meaning. See Daniel, pp. 141–147, 299–303; Beach, pp. 128–130, 181–184, 186, 187; Morris, pp. 114–119, 92, 93, 96–98.

(iii.) *Third Year.*

Make out a list of Greek prefixes, comparing them with Latin and English prefixes which have the same meaning; also note difference in meaning between prefixes spelt alike from the three sources, *e.g.*, *a*-bed, *a*-vert, *a*-pathy. Parsing and analysis. See Daniel, pp. 299–304, 139–141, 146, 149; Beach, pp. 181–187; Morris, pp. 92, 93, 96–98.

Arithmetic.

(i.) *First Year.—Boys.*—Reduction of improper fractions to whole or mixed numbers and *vice versâ*. Reduction to common denominators. See Lock, pp. 84–93; Pendlebury, pp. 86–91; Dixon and Beach, pp. 79, 80, 83; C. Smith, pp. 84–89; Brook-Smith.

Girls.—Complementary addition; examples in simple practice involving *subtraction* of one or more aliquot parts. See Lock, pp. 13, 25, 45; Pendlebury, pp. 11, 175–178; Dixon and Beach, pp. 15, 62, 63; C. Smith, pp. 17, 139–143.

(ii.) *Second Year.—Boys.*—Simple and compound proportion (application of theory of ratio to). See Lock, pp. 192–216; Pendlebury, pp. 185–202; Dixon and Beach, pp. 121–150; C. Smith, pp. 168–178.

Girls.—Same as First Year Boys.

(iii.) *Third Year.—Boys.*—Problems involving square root; miscellaneous examples on back rules. See Lock, pp. 298–300; Miscellaneous Examples, No. 1–32; Pendlebury, pp. 289, 292–294; Examination Papers (page 336), No. 1–28; C. Smith, pp. 220, 221; Miscellaneous Examples, No. 1–30.

Girls.—Multiplication and division of non-recurring decimals, with further study of the *theory* of decimals. See Lock, pp. 126–131; Pendlebury, pp. 128–135; Dixon and Beach, pp. 98–101; C. Smith, pp. 117–123.

Euclid.

(i.) *First Year and Second Year.*—To end of Proposition VI.

(ii.) *Third Year.—Boys.*—To end of I. 38.

Girls.—See First Year Boys' Mathematics.

Algebra.

(i.) *First and Second Years.*—To end of Subtraction.

(ii.) *Third Year.—Boys.*—To end of Multiplication; any cases involving brackets.

Girls.—See First Year Boys' Mathematics.

Mensuration.

Third Year.—Boys.—Sides and areas of right-angled triangles.

Teaching.

(i.) *Second Year.*—Flux's School Management, Ch. I.

(ii.) *Third Year.*—Flux's School Management, Ch. VII. to page 66.

Geography.—Complete the geography of England and Scotland. Learn complete map of England.

History.—To accession of Egbert (827) over England.

TEST QUESTIONS ON LAST MONTH'S WORK.

First Year.—1. Define a 'predicate,' and show that the 'object' and 'extension' are parts of the predicate.

2. What is a 'fraction,' a 'proper fraction,' an 'improper fraction'? Find the prime factors of 1,920 and 756, and thence find their G.C.M. and L.C.M.

Second Year.—1. Give the force of the following prefixes:—*sub*, *ex*, *pre*, *pro*, *dis*, *de*. What is the Latin preposition meaning *with*? Why does it take so many different forms when used as a prefix, *e.g.*, *con*, *com*, *col*, *co*, *cor*, *cog*, etc.?

2. What is a ratio? By what ratio must the ratio 3 : 2 be multiplied in order to produce the ratio 5 : 4?

3. State the rule for finding L.C.M. Find the L.C.M. of 9, 12, 15, 16, and 20, and prove that no lower number can be divided exactly by each of the given numbers. What are the next two lowest numbers exactly divisible by each of the given numbers?

Third Year.—1. Give the meanings of the following words, with special reference to their prefixes:—period, hypothesis, exodus, anatomy, anarchy, dyspepsia.

2. What are decimal fractions? What advantages are gained by using them instead of vulgar fractions?

Geography, for all Years.—1. In which parts of England are slate, lead, iron, and salt found?

2. Describe the mountains of Scotland.

History.—1. What causes led Julius Cæsar to visit Britain, and what do you know of the manners and customs of the people he found inhabiting it?

2. What traces of the Roman occupation of Britain still remain?

3. Explain the terms 'legion,' 'colonia,' 'centurion,' 'Count of the Saxon Shore,' 'emperor.'

HINTS ON THE WORK.

English.—Nearly all text books give a very good summary of the parts of speech and phrases that may form the subject of a sentence. The student should learn these, and make a list of them in his note-book, adding as many more examples as he can. Some text-books are, however, inconsistent in their treatment of the next section of our work, for having defined subject and predicate in such a way that every word in the sentence must form part of one or the other, they proceed to speak of the enlargement of the subject as though it were not part of the subject, and of the 'object' and extension as though they were not parts of the predicate. The student will see that the subject may consist of two parts, its nominative and its enlargements, though in its simplest form the subject consists only of a nominative.

Arithmetic.—Special attention should be paid to the method of Complementary addition. This consists in regarding a question in subtraction as one in which the sum of two or more quantities is given, and likewise all the quantities but one, which has to be found. Thus, applying the principle to a Simple Subtraction sum, we should proceed thus:

Take 478 from 839.	839
Working.—8 and **1** are 9; **7** and **6** are 13,	478
carry 1; 1 and **4** are 5; 5 and **3** are 8.	361

If Subtraction is systematically worked by this method, sums in which certain quantities have to be added, and their sum taken from a given quantity, can be worked in one step. *e.g.*, Take the sum of 538, 427, and 634 from 4,312.

Working.—4 and 7 are 11; 11 and 8 are 19;	4312
19 and **3** are 22, carry 2; or (naming only the	538
results), 4, 11, 19 and **3** are 22, carry 2;	427
2, 5, 7, 10 and **1** are 11, carry 1; 1, 7, 11,	634
16 and **7** are 23, carry 2; 2 and **2** are 4.	2713

Complementary addition enables us to work Long Division by the contracted or Italian method. For, just as we can take the sum of a number of terms from a given quantity, so also we can subtract the product of two numbers from another in one step.

Example: Divide 78425 by 354.

354)78425(221
762
545
191

Working.—354 into 784, twice.

2 × 4 are 8, 8 and **6** are 14; carry 1.
2 × 5 are 10, 10 and 1 are 11, and **7** are 18; carry 1.
2 × 3 are 6, 6 and 1 are 7 (nothing to add).
bring down 2. 354 into 762, twice.
2 × 4 are 8, and **4** are 12; carry 1.
2 × 5 are 10, and 1 are 11 and **5** are 16; carry 1.
2 × 3 are 6, and 1 are 7.
bring down 5. 354 into 545, once.
4 and **1** are 5; 5 and **9** are 14, carry 1; 1 and 3 are 4, and **1** are 5. Ans. 221, rem. 191.

The method will frequently save much time in working Practice.

Example: Find the cost of 365 articles at £7 18s. 10½d. each. Instead of finding cost at £7, and then taking aliquot parts for 18s. 10½d., find the cost at £8, and deduct cost at 1s. 1½d. Thus:

	£	s.	d.		£	s.	d.
1s. = $\frac{1}{20}$ of £1	365	0	0	= cost at	1	0	0
			8				
	2920	0	0	= ,,	8	0	0
1½d. = ½ of 1s.	18	5	0	= ,,		1	0
	2	5	7½	= ,,			1½
	2899	9	4½	= ,,	7	18	10½

½d. and ½d. = 1d., carry one.

1d. and 7d. are 8d., and **4d.** are 1s.

1, 6, 11s., and **9s.** are £1, carry 1; 1, 3, 11, and **9** are 20, carry 2.

2, 3, and **9** are 12, carry 1.

1 and **8** are 9; nothing and **2** are 2.

A short method like this will be worth more marks than a long round-about one.

For the treatment of Proportion, the student is strongly advised to study Lock's Arithmetic. A great deal of time is generally spent in learning how to reduce one quantity to the fraction of another, and in three cases out of four this is time wasted, for instead of applying the knowledge thus gained to the solution of problems in proportion, the student endeavours to get them out by help of dots, without in the least understanding the reason for the process. When we reduce £5 12s. 6d. to the fraction of £1 1s. 3d., we *find the ratio between* £5 12s. 6d. and £1 1s. 3d., or in other words we find how many times the first is greater than the second, viz.,

$$\frac{\text{£5 12s. 6d.}}{\text{£1 1s. 6d.}} = \frac{225 \text{ sixpences}}{43 \text{ sixpences}} = \frac{225}{43}.$$

Let us apply this to the question—'If 172 books cost £1 1s. 6d., how many can be bought for £5 12s. 6d.?'

Here we are told that 172 books cost £1 1s. 6d., and, therefore, if we pay $\frac{\text{£5 12s. 6d.}}{\text{£1 1s. 6d.}}$ (that is $\frac{225}{43}$) times as much money we ought to get $\frac{225}{43}$ times as many books.

$\frac{225}{43}$ times 172 books = 900 books.

Third-year girls should thoroughly master the reasons for the operations they perform in decimals; in division, special attention should be paid to the value of the remainder at any stage in the work, otherwise difficulty will be found in the second part of such a sum as the following:—How many pieces of string each ·085 yds. could be cut from a piece 9·3 yds. in length, *and what would be the length of the piece remaining?*

Geography.—In this subject Pupil Teachers should not be content to learn up a number of facts. The subject must be treated philosophically; it is not sufficient to know *where* the various manufactures are carried on, we should know *why* they are carried on there. Why are cotton goods made in South Lancashire rather than in Kent or Yorkshire? How do we account for the special trade of our several ports? Why has Witney fallen into decay and Rochdale risen? In what way have the physical features of our islands determined the races which should settle in the different parts of them?

History.—This subject must be treated in a similar way: not only should the facts be studied, but they should be studied in such a way as to see the relation they bear to one another. As a great deal of the history of the period set for this month is somewhat obscure, special attention should be paid to the social history—method of choosing the king; his powers; his counsellors (A.S. wita, a counsellor, wise man, hence *witena-gemôt*—*gemôt* meeting, *witena* of the wise men; always pronounce A.S. *g* hard as in *get*); local government; distribution of land, into *folc land*, or land belonging to the people at large, and *bôc land*, private land, or land held by a boc or charter; grades in society; state of learning, and connection between the latter and the prosperity of the different kingdoms.

Scholarship.—(Fourth Year.)

In the few days that remain to candidates for Queen's Scholarship this year, we can only recommend a careful study of those points in which they feel themselves weakest, and we wish them every success when the examination comes.

Those who intend to sit in December 1895 should get the work well in hand at once. Our course will include a thorough study of the subjects set out in the syllabus. In all probability that for 1895 will be practically the same as that for the present year. Students who have not yet got a copy of that syllabus, should write for one to the Secretary, Education Department, Whitehall.

We invite all who are following our course to send their difficulties, accompanied by the coupon, to Joseph Hughes & Co., marked outside 'P. T. Course'; matters of general interest will be treated in these columns, and the greatest possible amount of advice and assistance given.

Since a great deal of the Scholarship work consists of revision of the work of the first, second, and third years, Scholarship students are asked to look at the hints given in the work for those years, and thus save a large amount of repetition.

Work for December.

English.—History of Literature to 1400. Characteristics of Anglo-Saxon, and changes it underwent prior to 1400. Study of Nouns, Kinds, Person, Number, Case, Gender, Suffixes used in forming Nouns.

Arithmetic.—(*Girls.*) Division into Proportional Parts. Averages. (*Boys.*) Detailed study of principles involved in the four simple rules, and methods of teaching them. Miscellaneous examples.

Euclid.—(*Boys only.*) Euclid II. 4. Deductions on Book I. 1–26.

Algebra.—Harder factors. H.C.F.

Mensuration.—Area of circles.

Mathematics.—(*Girls.*) See Third Year Girls.

Geography.—Finish Geography of British Isles, with maps.

History.—To 1066, paying special attention to the social condition of the people, meaning of historical terms such as *thane*, *bôc-land*, *witena-gemôt*.

Teaching.—Flux's 'School Management,' Ch. 1–3.

Domestic Economy.—Those students who have not had the benefit of a course of scientific teaching should lay the foundations of this subject by studying a few principles of Chemistry and Physics, and of Human Physiology, which is simply the application of those principles to the human body. Excellent papers on this part of the work have appeared in 'The Practical Teacher.' The special points that must be mastered are:—Elements and compounds; difference between a mixture and a compound; combustion; solution; general properties of acids and alkalis; air and water. Three states of matter, general properties of solids, liquids and gases; effects of heat—change of temperature, expansion, change of state.

Test Questions on Last Month's Work.

English.—1. Why do we say that English is a Teutonic language, when on classifying the words in the dictionary only about one-third are Teutonic?

2. Give an account of the Beowulf.

3. What do you know of Cædmon, Cynewulf, and Bede?

Arithmetic.—1. Explain clearly what is meant by 'ratio' and 'proportion.'

2. Is the ratio between 10s. and 12s. 6d. a concrete or an abstract number? Give the origin and meaning of the signs : and : :.

3. Prove that if four terms are in proportion, the product of the means is equal to the product of the extremes.

4. What is meant by a 'mean proportional,' a 'third proportional,' 'compound proportion'? Find a mean proportional to 27 and 75, and a third proportional to 12 and 25.

N.B.—In last month's Scholarship Test Questions, Euclid I., read 'less' for 'greater.'

NOTES ON 'MADEMOISELLE DE LA SEIGLIÈRE.'

BY W. T. THOMPSON, B.A. (LOND.).
(*First Class French Honours.*)

The figures at the beginnings of the lines refer to the pages and lines of Macmillan's Edition (Foreign School Classics, 1s. 6d.). Thus 4.16 means p. 4, l. 16. As we quote the acts and scenes also, it should be possible for a student using any other edition to use these notes with advantage.

ACT IV.—SCENE 1.

79.1.—*gare la mine!* look out for the mine! See 76.13.

79.2.—*à qui de nous deux restera le champ de bataille*, which of us two will remain in possession of the field of battle, *i.e.*, which of us will be victor.

79.3.—*l'exploit est libellé*, the writ is drawn out.

79.5.—*le poulet doit être*, the charming document ought to be. *Poulet*, a love-letter, here used ironically of the writ.

79.7.—*je serai maître de la place*, I shall be master of the citadel.

79.8.—*Encanailler le marquis*, To lure the marquis into marrying his daughter to a man of low birth. *Canaille*, in

French, is rabble, scum. *Encanailler* is to degrade by introducing into low company.

SCENE 2.

80.8.—*Ah! ça sans reproche*, Well, without wishing to offend you.

80.8.—*Vous finirez—consultations*, You will eventually establish your office in my house.

80.10.—*ne saurait tarder*, cannot possibly be much longer.

80.11.—*je tiendrai bon*, I will remain firm.

80.12.—*que vient-il lui servir sur ce plat d'argent?* what is he bringing him on this silver salver?

80.15.—*que l'on vient d'apporter*, which has just been brought.

80.20.—*qu'est-ce que cela?* what is that? The second *que* is expletive.

80.23.—*Que me veut ce chiffon?* what is the meaning of this rag?

80.24.—*du papier timbré!* stamped paper!

80.26.—*Quel est le drôle qui s'est permis?* what rascal has dared?

80.30.—*Et que chante ce grimoire?* And what is this scrawl about?

80.31.—*ce jour d'hui*, this day. As in English, expressions which have become obsolete, or nearly so, in ordinary speech, are still used in legal documents. *Hui* is from Lat. *hodie*, to-day. Thus, *ce jour d'hui* = this day of to-day. So *aujourd'hui* = *au jour d'hui* = on the day of to-day.

80.32.—*sieur*, Mr. (Lat., *senior;* It., *Signor*; Span., *Señor*). This word appears as the compound *monsieur*, except in public and legal documents.

81.5.—*Agissant aux poursuites et diligences*, acting in accordance with proceedings taken by.

81.5.—*maître* (contracted Me.), a title given to barristers in France.

81.11.—*baillé assignation*, served a summons. *Bailler*, when not used in legal phraseology, = to let on lease (*bail*, a lease), or, to give. It must be distinguished from *bâiller*, to yawn.

81.15.—*indûment*, illegally. *Dû* is past part. of *devoir*, owe.

81.17.—*Comparoir*, appear, put in an appearance (as a legal term).

81.19.—*terme de pratique*, legal term.

81.22.—*jusqu'où*, how far.

81.24.—*dès demain, vu l'urgence*, to-morrow, considering the urgency (of the case).

81.26.—*Par devant*, before.

81.27.—*jugeant en état de référé*, sitting to hear motions.

81.30.—*Attendu que*, Seeing that.

81.30.—*le mort saisit le vif. Saisir* is to put into possession. (Compare our legal term, *to seise.*) This sentence means literally 'The dead (owner) puts the living (heir) into possession.' Translate, 'The heir succeeds immediately on the death of the owner.'

81.35.—*Voir dire*, Take notice (a legal term).

82.1.—*Tenu de déguerpir*, compelled to give up possession. *Déguerpir*, besides being a legal term, is a colloquialism = to pack off. The Marquis takes it in its colloquial sense as being deliberately used for the purpose of adding insult to injury.

82.1.—*Sinon y être contraint*, If not to be compelled to do so.

82.12.—*Vous allez le savoir* (lit., 'You are going to know it'). Translate, 'You will see very shortly.'

82.16.—*narguer*, vb. inf., defy.

82.16.—*pour me braver en face*, to brave me to my face.

82.20.—*Encore une fois, que prétendez-vous faire?* Once again, what do you mean to do?

82.21.—*Vous sauterez par cette fenêtre*, you will jump out of that window. *Sauter*, from Lat. *saltare*, leap. *Fenêtre*, from Lat. *fenestra*, window.

82.21.—*je vous couperai les deux oreilles*, I will cut your two ears off.

82.26.—*maraud*, noun m. s., rascal.

82.32.—*Allez la lui quérir*, Go and fetch it for him. *Quérir* is an almost obsolete verb, now employed only in the infinitive with *aller, envoyer, venir.*

82.33.—*Comment? voilà l'impression . . .?* What? is that all the impression (*i.e.*, which my fury has made on him)?

83.1.—*Si monsieur le marquis voulait me dire*, Would the marquis be kind enough to tell me?

83.4.—*Il n'a pas été long*, It (*i.e.*, the transport) has not been long.

83.8.—*Monsieur le marquis veut-il me permettre une observation?* Will the marquis permit me one observation?

83.10.—*Laquelle, Monsieur?* What (observation), Sir?

83.13.—*peut-être n'eût-il réussi qu'à se priver des services d'un homme*, Perhaps he would only have succeeded in depriving himself of the services of a man. When *peut-être, aussi* (therefore), *en vain*, and some few other expressions commence a sentence, the verb is put in the interrogative form.

83.15.—*abîme*, from Gk. *abyssos.* The circumflex denotes the suppression of an *s*, as if the derivation were from *abysma.*

83.22.—*que j'héberge depuis six semaines*, whom I have entertained for the last six weeks. *Héberger*, to entertain, is from the the same Teutonic root as *auberge*, inn.

83.29.—*Soit . . . je pouvais en douter*, Perhaps it is so, but I have my doubts about it.

83.30.—*Tête-bleu* (*Tête de Dieu*)! Zounds!

83.34.—*Méconnaître*, misunderstand. The verbal prefix *mé-* in French has the same force as the English *mis-. Fier*, to trust; *méfier*, mistrust.

83.35.—*qui ait jamais battu*, which ever beat. The subjunctive depends on the superlative (*le plus noble cœur*).

84.1.—*Vous nous la donnez belle*, that is a pretty story (lit., you give it to us beautiful). *Belle* is used here in an ironical sense. Other examples of the ironical use of *beau* and *belle* are furnished by *avoir beau*, to be in vain; *recommencer de plus belle*, to begin again worse than ever; *il m'en a compté de belles*, he told me a pack of falsehoods.

84.2.—*cet immonde papier*, that filthy paper (the writ). *Immonde*, fram Lat. *immundus*, unclean.

84.5.—*à l'insu de*, without the knowledge of. *Insu* is from *in*, not, and *su*, past part. of *savoir.*

84.8.—*usant des pouvoirs*, using the powers. *User de* = to make use of. *User* (transitive) = to wear out, consume.

84.8.—*ai cru devoir*, have considered it to be my duty. Distinguish *cru*, the past part. of *croire* (Lat. *credere*), to believe, from *crû*, past part. of *croître* (Lat. *crescere*), to grow.

84.12.—*Sachez-le bien*, Be assured of this.

84.18.—*tout à l'heure*, just now.

84.19.—*mieux vaut—escaliers*, it is better a hundred times to jump out of the window than to creep down the stairs.

To be better, in the sense of 'to be preferable,' is *mieux valoir.*

84.21.—*On traverse—séjourne pas.* People make haste to get out of an equivocal position, they do not linger in it.

84.25.—*je n'ai plus qu'un parti à prendre*, there is now but one course open to me.

85.6.—*Œdipe—Antigone.* Œdipus, King of Thebes, driven from his palace by his sons, was accompanied and tended in his wanderings by his daughter Antigone.

This is one of the finest scenes in the play. The ruin which is impending on the Marquis brings out the finest side of his character. But his old prejudices reawaken at the thought of a *mésalliance* for his daughter. Destournelles, with unsurpassable skill, succeeds in overcoming them.

85.10.—*Vous êtes bien ici*, you are very comfortable here.

85.17.—*Est ce que vous entrevoyez? . . .* Can you suggest (any means)?

85.33.—*de rapprocher*, of bringing nearer together. But *se rapprocher de*, to approach again.

85.36.—*veuillez m'apprendre*, be good enough to tell me.

86.2.—*épris*, past part. of *éprendre.* Translate 'smitten.'

86.8.—*Il manque un lièvre à vingt pas*, he misses a hare at twenty paces.

86.15.—*Qu'il la reçoive de vous*, let him receive it from you. The third persons singular and plural of the subjunctive present may be used as imperatives in French.

86.24.—*Je m'en doutais; à votre aise*, I thought so; let it be then as you please.

86.28.—*Je ne me soucie pas mal des besoins du siècle*, I don't care a button about the needs of the age.

86.30.—*Au temps où nous vivons, déroger c'est se ménager un appui.* In the age in which we live, to descend is the best means of procuring support for one's self. *Ce*, the nominative of *est*, is in apposition with *déroger*, which is the real subject of the sentence.

87.1.—*Ils vous signalent*, they point you out.

87.2.—*La Charte*, the Constitution which Louis XVIII. was compelled by policy to grant to his subjects on his accession to the throne in 1814.

87.5.—*Et comment, m'y prendrais-je pour détester la Charte ?* How could I possibly manage to detest the Charter. *S'y prendre* = to find a way to do something, to set about doing something.

87.7.—*Si une seconde révolution éclatait.* Suppose a second revolution broke out.

87.13.—*Que deviendra votre fille au milieu de la tourmente ?* What will become of your daughter in the midst of the tempest?

Tourmente, fem., tempest; *tourment*, mas., torment.

87.15.—*Le nom seul*, the very name. The *de* in the name of *de Vaubert* is a prefix indicating nobility. The bearer of such a name would probably, in a second revolution, run the same risks as the aristocrats had to encounter in the first revolution.

87.19.—*l'opportunité d'une mésalliance*, the expediency of a *mésalliance.*

L'opportunité = opportuneness, expediency; *l'occasion* = the opportunity.

87.21.—*vous vous créez*, you make for yourself.

87.26.—*bien à plaindre*, much to be pitied.

87.28.—*qui héritera de votre titre*, who will inherit your title.

87.33.—*Il n'est pas de sacrifice que je ne puisse faire*, there is no sacrifice which I cannot make. The subjunctive *puisse* depends on the negative *il n'est pas.*

88.2.—*quant à Bernard*, as for Bernard.

88.9.—*vous saurez à quoi vous en tenir*, you will know what to think.

88.16.—*Il n'est pas de force*, he has no strength.

SCENE 3.

88.24.—*Allons, ferme !* Now, be firm !

88.24.—*Abordez la question.* Tackle the question.

89.5.—*Que comptez vous faire ?* What do you intend to do ?

89.6.—*Mais . . . . Baronne . . . . je vous le demanderai.* Why . . . . Baroness . . . . I am about to put the question to you.

89.25.—*vous rendra au centuple les biens*, will return you a hundredfold the property.

89.28.—*aient*, have. The subjunctive depends on the question *croyez-vous ?*

90.2.—*bien d'accord*, quite in unison. *D'accord !* = Agreed ! *Etre, demeurer, tomber d'accord* = to be agreed.

90.7.—*j'ai mûrement réfléchi*, I have maturely reflected.

90.12.—*Où veut-il en venir ?* What is he coming to? What is he driving at ?

90.13.—*me faisait part*, informed me. *Faire part de quelque chose à quelqu'un* = to inform someone of something. *Billets de faire part* are circular letters announcing a death, marriage, etc.

90.16.—*En effet*, you did.

90.17.—*Je ne suis pas le marquis de Carabas, moi.* I am no Marquis of Carabas. The allusion is to Béranger's well-known *chanson.* The Marquis of Carabas typifies the French aristocrats who returned with Louis XVIII., and who failed to realise that the old feudal France which they had known had gone for ever.

90.18.—*Autres temps, autres mœurs !* Manners change with the times. This is a well-known French proverb.

90.20.—*Pour qu'à son tour il vienne*, In order that in its turn it may come.

90.23.—*de marier votre fille à Bernard*, to give your daughter in marriage to Bernard. *Marier* is said of the parents who arrange marriages for their children, or of the priest who performs the ceremony. To get married = *se marier. Etre marié* = to be married.

90.33.—*Vous portiez un coup de Jarnac*, you were delivering an unexpected blow. The phrase *un coup de Jarnac*, for an unexpected and decisive blow, is derived from the unexpected stroke with which the *Sire de Jarnac* killed *La Châtaigneraie* in a duel.

91.3.—*le cœur m'en lève ;* my heart rises at it ; *i.e.*, I am sick of it.

91.3.—*Morbleu ! vous me pousses à bout.* Zounds! you drive me to desperation.

The poor simple Marquis, between a clever and cunning man on the one side, and an equally skilful woman on the other, is certainly to be pitied.

91.6.—*Va pour la guerre !* A fig for war.

91.6.—*sans l'avoir faite*, without having waged it (*i.e.*, war). The past participle *faite* is fem. sing. because the direct object *la* (= *guerre*) precedes it.

91.9.—*si mademoiselle—se fera complice*, whether Mdlle. de la Seiglière will become (lit. will make herself) an accomplice.

In the sense of 'if,' *si* can only be followed by the present and imperfect tenses. In the sense of 'whether,' or, in other words, when it introduces a noun object sentence, it may be followed by the future or conditional tense.

91.14.—*Vous le voyez*, You see (lit. 'you see it').

91.16.—*la conscience même*, the very conscience. But *la même conscience* = the same conscience, and *même la conscience* = even the conscience.

91.18.—*C'est que j'entends me réserver*, it is because I mean to reserve for myself.

91.21.—*je n'assisterai pas à votre honte*, I will not be present at (*or*, I will not be a witness of your shame).

SCENE 4.

91.24.—*à propos*, in the nick of time ; at the right moment.

91.25.—*Que se passe-t-il donc.* What is taking place, then? *Passer*, to pass ; *passer chez quelqu'un*, to make a call on someone ; *se passer*, to happen ; *se passer de*, to do without ; *passez-moi ce mot*, forgive me that word.

92.2.—*à l'œuvre*, set to work.

92.3.—*je sais ce qu'il me reste à faire*, I know what remains for me to do.

SCENE 5.

92.7.—*Mais comment préparer ma fille ?* But how shall I prepare my daughter ? The infinitive is used in this way when the question does not demand an answer, but is only a more graphic way of stating a negative.

92.8.—*Allez droit au but*, Go straight to the point.

SCENE 6.

92.11.—*que veut dire madame de Vaubert ?* What does Madame de Vaubert mean ?

92.13.—*Il a beau dire*, it is all very well for him (Destournelles, when he says *allez droit au but*) to talk. See 84.1.

92.21.—*saurait-il ?* . . . Can he possibly know ? . . . This is an instance of the use of the conditional to express doubt or possibility.

93.1.—*Comment ?* What ?

93.5.—*Ce n'est pas là ce que je te demande, That* is not what I ask you. The addition of *là* gives emphasis to *ce.*

93.5.—*Ce mariage te sourit-il ?* Is this marriage agreeable to you? (Lit. does this marriage smile on you ?)

93.8.—*Il s'agit de ton bonheur*, the question concerns your happiness.

93.13.—*quand je ne serai plus*, when I am no more. *Quand, aussitôt que, dès que*, require the future after them in French, when futurity is implied.

93.16.—*Belle aubaine que son dévouement*, his devotion is a fine godsend. *Que* is expletive.

93.17.—*qui ne fera que la chasse aux papillons*, who will only hunt butterflies.

93.18.—*bêtes à bon Dieu*, lady-birds.

93.23.—*Tiens*, Why.

93.25.—*Ça n'a pas encore vingt-huit ans*, He is not yet twenty-eight years old. *Ça* (contraction of *cela*) is used familiarly for *il.*

93.26.—*Ça vous a déjà un bout de ruban à la boutonnière*, he has already a bit of ribbon in his button-hole (*i.e.*, he has a

decoration). *Vous* is an instance of the *ethic dative*. Compare Shakespeare, 'he plucked *me* ope his doublet.'

93.28.—*ça s'est fait tuer*, he got killed.

93.34.—*Mariage et fiançailles sont deux*, marriage and betrothal are not the same thing.

94.3.—*mon repos en dépend*, my peace of mind depends on it.

94.14.—*je foulerais aux pieds*, I would trample under foot.

94.15.—*et mes aïeux en penseraient ce qu'ils voudraient*, and my ancestors might think of it what they pleased. *En penser* = have an opinion about it; *y penser*, to think of it, reflect on it.

94.16.—*et toi, tu vis, mon Hélène*, and *you* live, my Hélène. The addition of *toi* gives emphasis to *tu*. *Vis* is pres. ind. 2 s. of *vivre*, to live. *Vis* is also preter. 2 s. of *voir*, to see. See 90.17.

94.30.—*je vous en conjure*, I entreat you.

94.32.—*c'était moins difficile que je ne croyais*, it was less difficult than I believed. A sentence depending on a comparative (*moins difficile*, a comparative of inferiority) requires *ne* with the verb.

SCENE 7.

95.2.—*ce qu'on vient de me dire est-il vrai ?* is what I have just been told true ?

95.7.—*c'est bien de cela qu'il s'agit !* that is the very point which is in question !

95.8.—*J'en apprends de belles sur votre compte*, I hear some nice tales about you. See 84.1.

95.12.—*Vous vous êtes oublié jusqu'à porter vos vues*, you have so far forgotten yourself as to aspire. Notice that the past participle is singular here, agreeing with *vous* in *sense*, but not in *grammatical form*.

95.16.—*qui n'a fait que traverser mon cœur*, which has only traversed my heart.

95.18.—*A d'autres !* Nonsense ! Lit. 'to others,' *i.e.*, '(tell) it to others.'

95.21.—*que les choses peuvent se passer de la sorte*, that things can be settled in that way.

95.24.—*faire sa valise*, pack up one's portmanteau. *Faire sa malle*, pack up one's trunk ; *défaire sa malle*, unpack one's trunk.

95.28.—*Que diable voulez-vous que je fasse de votre sang ?* What the deuce do you wish me to do with your blood ?

SCENE 8.

96.12.—*Vous n'êtes pas de trop*, You are not in the way.

96.16.—*mais il ne convient pas que ma fille . . . .* but it is not fitting that my daughter . . . .

96.20.—*c'est moi seul que cela regarde*, it is myself alone whom that concerns.

96.22.—*c'est à moi de parler*, it is my turn to speak.

96.23.—*j'apprends à l'instant même*, I learn at the very instant, *i.e.*, I have just learned. See 91.16.

97.1.—*Qu'entendez-vous par là ?* What do you mean by that ?

97.4.—*un galant homme*, a gentleman. But *un homme galant*, a lady's man.

97.10.—*par son ancien fermier*, by his late farmer, *or* old farmer. *Ancien* is 'old' in the sense of 'former'; *vieux* is 'old' in the sense of 'aged.'

97.12.—*depuis six semaines vous n'êtes plus chez votre père*, for the last six weeks you have no longer been living in your father's house. *Depuis* with the present tense marks the *beginning* of a state or action which is still continuing.

97.11.—*le seul fait*, the mere fact. *Seul* preceding its noun = 'mere'; following it, 'alone,' 'solitary.'

97.17.—*Chansons que tout cela*, that is all nonsense. *Que* is expletive here.

97.19.—*pour éteindre un procès*, to put an end to a lawsuit.

97.23.—*aujourd'hui même*, this very day. See 91.16.

97.28.—*faites à*, fitted for.

97.30.—*sied*, pres. ind. 3s. of *seoir*, to suit.

97.34.—*une transaction*, a compromise, an arrangement.

97.34.—*que je m'abstiens de qualifier*, to which I refrain from giving a name.

98.10.—*de trouver votre fille au-dessous des devoirs*, to find that your daughter will not rise to the level of the duties.

98.11.—*que pourra lui imposer le soin de votre honneur*, which regard for your honour may impose on her. When the relative *que* commences a sentence, the subject and predicate are inverted in order.

98.12.—*en vrai gentilhomme*, as a true gentleman.

98.23.—*Au lieu de nous retirer tête haute*, instead of withdrawing, holding our heads erect.

98.35.—*vous ne vous aperceviez pas que j'étais le prix d'un marché*, you did not perceive that I was the price of a bargain.

99.2.—*si monsieur ne fût venu à temps*, if Monsieur de Vaubert had not come in time. *Si-ne* = the Latin *nisi*, unless.

SCENE 9.

100.6.—*pour vous rendre à tous la vue ou la raison*, to restore to all of you sight or reason.

100.17.—*le domaine public s'en arrangera volontiers*, the public domain will willingly take charge of it. The 'public domain' means 'is the property of the State.' The meaning is that if the Marquis does not accept the gift, Bernard intends to hand over the property to the State.

100.21.—*si vous l'emportez*, if you gain the victory.

100.31.—*qui s'aiment*, who love each other.

100.31.—*pour river l'un à l'autre*, to bind to each other.

101.4.—*Il serait possible !* Can it be possible !

101.7.—*je ne reviens pas sur ma parole*, I do not withdraw my word.

101.21.—*A la bonne heure donc*, It is all right then.

101.31.—*C'est ma plus belle affaire !* It is the most brilliant victory I have won (as a lawyer).

102.3.—*ma nomination !* my nomination ! (to the post he had been seeking). See Act III. Scene 1.

102.7.—*J'y gagne.* I am the gainer by it.

THE 1894 SCHOLARSHIP EXAMINATIONS.

BY GEORGE BEACH, M.A., LL.D. (DUBLIN).

Author of '*Elements of English*,' '*A Girls' Arithmetic*,' '*Entertaining Readers*,' *etc.*

I. MISCELLANEOUS.

(*a*) In reply to various correspondents, we again state that the Scholarship candidates who sat in July last need not teach, recite, or read again for the December Examination ; their marks will be carried on.

(*b*) As regards optional subjects, the marks for Science must have been secured during the current year; but in the case of Drawing there is no such restriction. Whatever year the success was achieved in matters not, the marks are reckoned. Note also that the passes and classes allowed as equivalents for—

(1) Freehand (Subject 2*b*),
(2) Model (Subject 3*a*),
(3) Shading from casts (Subject 5*b*),
(4) Practical, Plane, and Solid Geometry, Elementary Stage (Science Subject I.),

for the purposes of the Elementary Drawing Certificate (1st Class) are also allowed as equivalents in the Queen's Scholarship Examination.

(*c*) Candidates taking Latin as an alternative for English Grammar and Composition may not also take Latin as an 'optional subject'; and we may also state that in our opinion the marks for English are much more easily obtained than for Latin.

(*d*) Candidates not employed in public elementary schools will have their Reading and Repetition heard at the place of examination. No opportunity will be afforded them of securing the 80 marks for Practical Teaching, but it is commonly supposed that in calculating the percentage necessary for the various classes, these four-score marks are excluded in their case from the maximum considered attainable.

Nevertheless the external candidate is here somewhat handicapped (and probably not unjustly), for the percentage of marks obtained on this practical subject is judged to be considerably higher than that awarded on the ordinary paper work.

(*e*) Again, it must be repeated that Music should not be neglected. Too often its 50 marks 'go begging.' There is no subject where good marks are obtained with more facility, and where the questions can more easily be 'spotted' beforehand. Anyone who has intelligently mastered the questions set for the last six examinations cannot fail to do well.

The Practical part many of the men candidates whose voices at present are more low than sweet, and who sing in quavers all tunes set in any measure, neglect as being beyond their melodious powers. Be it so, yet nevertheless attempt to sing; and after a few croaks, ask to be allowed to abandon that portion of the test, and to be examined in time and ear tests. These will be sufficient, if well done, to score the maximum of marks.

Candidates cannot take the practical portion without attempting the theoretical, but they may attempt the latter without the former.

In the theoretical examination the answers must be confined to one notation, but the notation selected need not be the one employed in the practical test.

II. WHAT TO REVISE.

(*a*) The examination commencing on 19th December leaves us only about a fortnight for revision, which is little enough for the purpose.

Attempt not therein to do any paper-answering, neither should ye endeavour to cover over again the whole area of the syllabus, for verily the effort would be vanity, and the result confusion of spirit.

This is the time when groaning we confess that of the making of books there is no end, and much study is a weariness to the flesh.

(*b*) Do no writing, except an exercise or two per diem in copy-setting, and no reading whatever except that which appertains to the examination. If recreation be needed (and indeed it is essential) seek it among the quietude of out-door nature, avoiding the busy haunts of men and the distractions of public amusements.

(*c*) In ARITHMETIC look up the theory and proofs of rules—illustrations of fractional operations—the principles of clock sums, problems of motion, 'A, B and C' sums, repeating decimals, stocks and discount. In this last remember that '*the Discount is the Interest of the Present Worth*,' and that every 'Amount sum' in Simple Interest can easily be converted into a Discount or Present-worth problem, *e.g.*, 'Find the amount of £110 for 5 years at 4 per cent.' Answer, £132. Compare this with 'Find the present worth of £132 due in 5 years at 4 per cent.' Answer, £110.

(*d*) GEOGRAPHY of British Isles, India, China (including Corea), and Japan need especial attention; and at present commercial geography is at a premium. The map set will be some part of the British Isles. It is very probable that it will be a section which comprises a portion both of England and Scotland—there will, however, be considerable choice. The lines of latitude and longitude must on no account be neglected.

This map is rather catchy, as England and Scotland when drawn separately are often to different scales. A map of the Irish Sea is also possible.

(*e*) HISTORY. Of course the special period (Charles I.) demands most application. The relative importance of the respective battles, and the part they played in the struggle as a whole, require investigation. In general, revise your Date Book, and 'get up' dynastic tables, tables of campaigns and of chief authors.

(*f*) ENGLISH. Know how to parse such words as *like*, *for*, *until*, *can*—to analyse sentences containing copulative verbs, indeterminate verbs, such as *must*, interjections or nominatives of address followed by subordinate sentences—to draw up a table of literature, and to distinguish the factitive object. The Passive Voice, for some unknown reason, is often a conundrum, especially to the ladies. But here are three ways whereby it may be discerned—the first one a rough and ready method, but the other two infallible rules. Take, for example, the two sentences—

'*John broke the window*' (Active Voice).
'*The window was broken by John*' (Passive Voice).

To these apply the three tests:—

(1) When a transitive verb does not govern an object, the verb is *generally* in the passive voice—*was broken* does not govern any object.

(2) When to the PAST participle of a transitive verb some portion of the verb *to be* is prefixed, the compound verb is in the passive voice. *Was broken* is such a compound form.

Care must be taken not to confuse the present participle with the past; for the compound form then resulting is not passive, but simply a progressive, imperfect, or continuous form of the active voice. We can say in the active voice '*John was breaking the window.*'

(3) When the subject of a transitive verb is *not* the Doer, the verb is in the passive voice. *Window* is the subject of *was broken*, but it is not the doer.

(*g*) SCHOOL MANAGEMENT. Study the Time-Table of your own school, the question of rewards and punishments, the subject of Object Lessons and Suitable Occupations, and be prepared to give the titles of poetical extracts which you would select for the various standards. Learn also the proper proportions of the various manuscript letters, and the advantages and disadvantages of the various kinds of reading. You need not go beyond 'Flux'—an admirable book.

(*h*) MUSIC. Minor Scales in their threefold forms—transcription—transposition—the code requirements for the various divisions, are the most salient points. Howbeit, as aforesaid, it will be practically sufficient to conquer thoroughly the queries of the last six examinations.

(*i*) ALGEBRA. Factors; G.C.M.; L.C.M.; Theory of Rules (especially of Proportion and Quadratics) all require attention.

Show that $a + b$ is a factor of $a^{2m+1} + b^{2m+1}$ and

,, $a - b$,, $a^m - b^m$.

(*j*) MENSURATION. The salient points are:—squares within squares—overlapping squares—squares within circles—circles within squares—solution of triangles having given (i) the sides, (ii) the area and ratio of the sides, (iii) area and two sides, (iv) two sides and right angle—easy trapezium.

(*k*) EUCLID. Learn the numbers of the most commonly referred to Propositions, Axioms, Definitions, and Postulates—converse of Propositions—deductions on Euclid I. 5, on parallel lines, on I. 47, on II. 4, II. 11, and II. 14—and the equivalent algebraical formulæ for propositions of Book II.

The following are the chief deductions set at the last five examinations:—

(i) *July* '94. (α) Between two given parallel straight lines place a straight line of given length terminated by them. Is this always possible?

(β) If the equal sides of an isosceles triangle are PQ, PR, find S and T in PQ and PR respectively, so that QS, ST, TR may be equal.

(γ) ABC is an acute-angled triangle, and BC (which is less than AB) is produced to D. Find a point P in AC so that the angle BPA = angle ACD.

(δ) Show that the angle contained by the bisector of the vertical angle of a triangle and the perpendicular to the base is equal to half the difference of the base angles.

(ε) If in the triangle ABC, the sides AB, BC, CA be produced to F, D, E respectively, so that BF = BA, CD = CB, and AE = AC, then triangle FDE = seven times triangle ABC.

(ζ) The sides AB, AC of a triangle ABC are produced to E and F respectively. The lines bisecting the angles EBC, BCF meet in O. Show (1) that the perpendiculars OL, OM, ON let fall upon BC, AF, and AE respectively are all equal, and (2) that AM and AN are each equal to half the perimeter of the triangle.

(η) If ABC be an acute angle, and BD, CE be drawn at right angles to AC and AB respectively, then the rectangle contained by BA, AE is equal to the rectangle contained by CA, AD.

(θ) In every triangle the sum of the squares on two of the sides is equal to twice the square on half the base, together with twice the square on the line drawn from the vertex to the middle point of the base.

(ii) '93. (ι) Construct a triangle having given two sides and an angle opposite to one of them. Show that there may be *two* constructions, *one*, or *none*.

(κ) ABC is a triangle, of which AB is greater than AC. The bisector of the angle A meets the base in D. Show that the angle ADB is an obtuse angle.

(λ) The line which joins the middle points of the oblique sides of a quadrilateral, whose other sides are parallel to one another, is equal to the semi-sum of the two parallel sides. (*Also in* '91.)

(μ) Prove that in a right-angled triangle the middle point of the hypotenuse is equally distant from the three angles.

(ν) In any triangle ABC, if BE, CF be perpendiculars on any line through A, and D be the bisection of BC, show that DE = DF.

(ξ) If from the right angle of a right-angled triangle lines be drawn to the opposite angles of the square described on the hypotenuse, the difference of the squares on these lines is equal to the difference of the squares on the two sides of the triangle.

(iii) '92. (ο) If T be the middle point of the diagonal QS of a quadrilateral PQRS whose opposite sides are equal, then P, T, R are in a straight line.

(π) PQ, PR, the equal sides of an isosceles triangle PQR, are produced to S and T, so that PS, PT are equal. RS, QT intersect in M. If the angle SQT is equal to the angle PQR, then the angle SMQ is equal to twice the angle QPR.

(ρ) Find a point in the diagonal produced of a square, from which if a line be drawn parallel to any side of the square, meeting another side produced, it will form, with the produced diagonal and produced side, a triangle equal to the given square.

(σ) If one angle of a triangle be four-thirds of a right angle, the square on the side subtending that angle is equal to the sum of the squares on the sides containing it, together with the rectangle contained by those sides.

(iv) '91. (τ) That sum of the diagonals of a quadrilateral is less than the sum of any four lines that can be drawn from any point (except from the intersection of the diagonals) to the four angles.

(υ) If ABC be a triangle in which C is a right angle and DE be drawn from a point D in AC at right angles to AB, prove that the rectangles AB, AE, and AC, AD will be equal.

(v) '90. (φ) PQR is a right-angled triangle; from the right angle R, RS is drawn bisecting PQ at S and RT at right angles to PQ, meeting it at T. Show that the angle SRT is equal to the difference of the acute angles at P and Q.

(χ) T is any point within a parallelogram PQRS, and lines are drawn from it to the angles. Show that the triangles TPQ, TRS are together equal to the triangle PQR.

(ψ) PQR is a triangle right-angled at P; S is a point in PR; T is a point in PQ. Prove that the sum of the squares on RT, SQ is equal to the sum of the squares on QR, ST.

(*l*) Domestic Economy.

Preparation of Food.—Cooking utensils; The oven; methods of cooking, with the time required for the various joints, and the applicability, advantage, or drawbacks of these methods; How to cook fish, potatoes, green vegetables, poultry and butcher's meat; Recipes for batter pudding, plum pudding, rice pudding, potato pie, pea soup, ordinary soup, mutton broth, beef tea, barley water, oatmeal porridge; How to make bread; Manufacture of cheese; How to preserve food; Utilisation of scraps of meat, bread, dripping; Employment of condiments; Hot *versus* cold food; Why are the French better cooks than we? Series of dinners for lone teachers.

Health.—Simple rules for preservation of health; Preservation of health of teachers and scholars; Effect of good temper upon health; Sensible clothing; Fashionable clothing; Danger of schoolroom being cloakroom; Importance of physical training, regular exercise, and special exercises for infants and girls; Supervision of playground sports; Early rising; Evils of flat desks; Personal cleanliness: cleanliness of premises; Temperature and fixing of baths; Lighting, ventilating, and draining of premises.

Sickness, etc.—Cases of emergency, such as burns, scalds, drinking boiling water, cuts, choking, stunning, fainting, convulsions, and sprains; Improvisation of a stretcher; Symptoms and first treatment of whooping-cough, measles, croup, small-pox, typhus fever, and scarlatina; Precautions against infection and contagion; Disinfectants; Nursing of convalescents.

Clothing.—Use of Clothing; Clothing for head, body, feet; Suitable clothing for teachers; Origin, preparation, use, selection of clothing materials; Quantity required, and cost of materials for ordinary garments; Removal of grease, ink spots, and stains.

Washing.—Advantages or otherwise of a washing-machine; Appliances for washing; What articles must be washed by hand? What articles must be washed without soap or without soda? What articles must not be starched, mangled, or long-dried? Preparation for washing-day; A Schoolmistress's washing-day; Special washing of blankets, prints, woollens, linens, muslins; Getting-up of linen.

III. Examination Hints.

(*a*) Don't work after midday on Monday, 17 December.
(*b*) Lodge near the examination room.
(*c*) Leave all study books at home.
(*d*) Take plenty of moderate exercise in examination intervals.
(*e*) Live plainly and regularly. Abstain from intoxicants.
(*f*) Head your papers first, and comply to the minutest iota with the printed and oral directions.
(*g*) Connive at no breach of regulations.
(*h*) Work with watch upon desk.
(*i*) Answer the easiest questions first.
(*j*) Don't omit deductions in Euclid, proofs in Arithmetic and Algebra, maps in Geography, dates in History, notes of lessons in School Management.
(*k*) Be sure to work the music paper.
(*l*) Take with you all requisite particulars as to science, drawing, etc.
(*m*) Don't forget your examination 'permit.'
(*n*) Continue in the examination to the last, revising and re-revising.
(*o*) Revise each mathematical step as set down.
(*p*) Draw a plain map at first, afterwards elaborate if there be time. The map must be drawn.
(*q*) Take into the examination room an assortment of pens, red ink, black, blue, and red leads, penknife, and indiarubber.
(*r*) Don't write in the margin or between lines. This is worse than useless.
(*s*) Don't write round the question, get to the point.
(*t*) Where possible, draw up on scribbling side a synopsis of intended answer.
(*u*) Practise the copy-setting before writing the specimen.
(*v*) Use only the authorised contractions in Euclid and parsing.
(*w*) Write the Euclid, if necessary, in two columns.
(*x*) Analyse on the tabular system, unless otherwise directed.
(*y*) In French and Latin do not omit the parsing.
(*z*) In disciplinary questions in School Management refrain from advocating corporal punishment.

IV. The MS. Examination Book.

This consists of six leaves (in addition to cover) of excellent white foolscap, ruled on the right-hand side with thirty-two lines for answering, and left blank for rough work on the left-hand, or under side of leaf. About one-fifth of the ruled side is, on the left, occupied by an unruled margin, which must not be in any way used by the Candidate, but must be scrupulously reserved for the Examiner's marks.

Subject.	No. of Questions.	No. of Answers Allowed.	Total Time.	Average time per Answer.	Average space per Answer.
			hours.	minutes.	lines.
Arithmetic (Men)	17*	14*	3	13	11
Euclid, Algebra, and Mensuration	18*	18*	3	10	9
Arithmetic (Women)	16*	12*	3	15	13
Domestic Economy	14	5	2½	30	31
Geography	11*	5 }	3	18	15
History	7*	5* }			
School Management	17*	8*	2½	19	19
English	11*	6*	2½	25	26
Music	6	4	45 min.	11	Allotted
Latin	8*	8*	2 hours	15	19 lines
German	5*	5*	2 ,,	24	31 ,,
French	5*	5*	2 ,,	24	31 ,,
Greek	8*	8*	2 ,,	15	19 ,,
Hebrew	11*	6*	2 ,,	20	26 ,,

Number of Questions marked thus (*) is not the nominal, but the actual, number, for two distinct questions are often placed under one head.

'*Lines per answer*' means *full* lines undiminished by margin.

In the Mathematics only is the space circumscribed, but several of the questions can be answered in less than eight lines. Nevertheless it is advisable in the Euclid portion to write in two vertical columns on one page, and thus save space.

SELECTED GOVERNMENT QUESTIONS.

1. Write a short essay on 'The use of Pictures in Teaching.'

2. Analyse the following sentence, and parse the italicised words :—

'*When* Henry the *Eighth* attempted *to raise* a forced *loan* of unusual amount by proceedings of unusual rigour, the opposition *which* he encountered *was such as appalled even his* stubborn and *imperious* spirit.'

3. Draw a map of Ireland.

4. Explain the following terms: meridian of Greenwich, equatorial diameter, ecliptic, solstice, estuary, confluence, tropics, and plateau.

5. Describe briefly the courses of the Ganges and the Nile.

6. Give some account of the Soudan, Manitoba, and Ceylon.

7. Say what use you think it right to make of tracing in teaching writing. Write in largehand the five capital letters : B, K, Q, M, and W ; and point out the commoner faults made by learners in forming them.

8. Explain the terms : Catholic Emancipation, Petition of Right, Five Mile Act, Habeas Corpus Act, and give an account of the second and fourth of these measures.

9. What do you know of Lambert, Bradshaw, Hyde, and Rupert?

10. Find by practice the value of 73,360 articles at £5 14s. 3½d. each. Ans. £419,298 5s. 0d.

11. If 20 horses and 196 sheep can be kept for 9 days for £7 15s. 0d., what sum will keep 15 horses and 72 sheep for 8 days, supposing 5 horses eat as much as 76 sheep? Ans. £4 2s. 8d.

12. A tax of 5d. in the £ is paid on a certain sum, and a further tax of 1½ per cent. on the remainder. The sum now remaining is £31 2s. 9d. Find the original sum. Ans. £32 5s. 8$\frac{4}{19}$d.

13. (*Men only.*) If a straight line fall on two parallel straight lines, it makes the alternate angles equal to one another. Show that the lines bisecting the alternate angles of an equilateral triangle will if produced form another equilateral triangle. What is the magnitude of this triangle compared with the original one?

(*Women only.*) What materials and appliances would be required for the teaching of needlework to Standards III. and IV. ; and what ought children in those standards to be able to do in order to fulfil the requirements of the Code?

14. (*Men only.*) If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise their bases equal, the angle which is contained by the two sides of the one shall be equal to the angle contained by the two sides equal to them, of the other.

What is the converse of this proposition? Is it universally true?

(*Women only.*) Name the chief ingredients which can be made use of in the preparation of soup. Give two recipes for the making of cheap and nourishing soups.

15. (*Men only.*) The diagonals of a rhombus are 88 and 234 feet. Find the area, the length of a side, and the height of the rhombus.

Ans. 10,296 sq. ft. ; 125, 82·368 ft.

(*Women only.*) Draw out a week's table of expenditure for an artisan's family, consisting of himself, his wife and three children from 4 to 10 years of age, the father's earnings being 30s. per week.

16. *Men only.*) Prove the rule for dividing one fraction by another.

Simplify

$$\frac{x^3+2}{(x-2)\,2\,(x^2+1)} - \frac{4}{5\,(x-2)} - \frac{x+2}{5\,(x^2+1)}.$$

Ans. $\frac{x^2+2}{(x-2)\,2\,(x^2+1)}$.

(*Women only.*) Show the importance of proper light and ventilation in schools. What is needed in a school-room in order to secure these conditions? How would you obtain ventilation without draught?

17. (*Men only.*)
$$\left.\begin{aligned} \frac{3x+1}{7} - \frac{2x-y}{2} &= \frac{2y-x}{8} \\ \frac{4x-2}{3} - \frac{4y-5x}{2} &= \frac{x+y}{5} \end{aligned}\right\}$$

Ans. $x = 2$; $y = 3$.

COMING MEN.

XIII.—MR. HARRY WARD,

Huntingdon Street Higher Grade Board School, Nottingham, Hon. Treasurer of National Federation of Assistant Teachers.

No reader of the 'PRACTICAL TEACHER' has yet, we think, had reason to adversely criticise the action of those who are responsible for the selection of the gentlemen who are described by the appellation which heads this column. A revisal of the names which have for twelve months past occupied in turn their positions in this series will display an array not of 'veterans' certainly, but of individuals whose labours in the cause of education are remarkable and unique. Many of them have for years past been closely associated with those movements which have from time to time been initiated for the purpose of advancing educational progress. Some have caught the infection engendered by recent efforts on the part of their more experienced colleagues, and have rapidly forced their way into the front rank of educational reformers. In the latter category we may place the subject of our present sketch.

Mr. Harry Ward was born at the ancient city of York in 1867, and was educated at the York Manor Boys' School. This school, which is often known as the 'Palace of the Stuart Kings,' was under the superintendence of Mr. G. K. Hitchcock, who took a part in the formation of the N.U.T. It was at this school that Mr. Ward served his apprenticeship, and he speaks highly of the excellent training he received. One particular feature of his apprenticeship was his connection with the then existing Pupil Teachers' Mutual Improvement Society. He was for some time secretary of this organisation, and also editor of its official magazine. His striking ability in debate and his mastery of language is attributable in no mean degree to the experience gained thereby, and he is surprised that at the present time similar societies are not prevalent.

At the completion of his apprenticeship Mr. Ward entered the Training College of St. Mark's, Chelsea. Here he spent the years 1886–7, during which time the change from the principalship of Canon Cromwell to that of Mr. G. W. Gent took place.

Mr. Ward is loud in his praises of St. Mark's, and displays all those traits of affection for his *alma mater* which are so characteristic of the collegian. After completing his training he was for a short period engaged at Alderman Newton's Higher Grade School, Leicester. He then entered the service of the Nottingham School Board, being appointed Assistant Master at the St. Ann's Well Road Board School.

From thence he was in 1891 transferred to the Huntingdon Street Higher Grade Board School, and there he is at present engaged.

His connection with the N.U.T., though not of an extremely extended character, is marked with creditable labour.

Mr. Ward is one of those acquisitions which the N.U.T. has secured by the spread of the Assistant Teachers' national movement. He is one of the many Assistant Teachers who, realising that the policy advocated by their leaders was a sound one, threw himself into the strife and became imbued with the tone and spirit of unionism. He represented the Nottingham Association at the Leeds, Liverpool, and Oxford conferences of the N.U.T. As a member of the committee, and as the Social Secretary of the Nottingham branch of the N.U.T., he has accomplished useful work. Our conversation on Union matters elicited the following observation:—

'I was much impressed,' said Mr. Ward, 'with the Leeds Conference, and particularly with the earnest band of assistants there present. I realised the work that lay before us, and I was satisfied that we possessed men of sufficient ability and perception in our ranks to steer us clear of difficulties. I had been present at the conference of Assistant Teachers held in the early part of '92 at Sheffield, and the hearty manner in which the Leeds Conference supported the proposals drawn up by the assistants at Sheffield convinced me that we had inaugurated a successful policy.'

Yours faithfully, H. Ward

At the Oxford Conference Mr. Ward was concerned with the resolution which was adopted in favour of restricting the number of scholars to be placed under the charge of one Teacher. Then, and subsequently when the question was being discussed in the columns of the 'Schoolmaster,' he upheld the principle contained in the resolution.

With the movement that led to the formation of the National Federation of Assistant Teachers, Mr. Ward was closely associated. The first committee which represented the Assistant Teachers nationally, namely, the one elected at Sheffield in January 1892, claimed him as a member. Again at the Nottingham Conference of Assistant Teachers he was elected to the committee, and at the first meeting of the committee he was voted to the chair.

As Chairman of the Assistant Teachers' National Committee he discharged his duties in a most praiseworthy manner.

In this capacity it became his duty to preside over the memorable conference held at Derby last year.

The history of the keen struggle on the question of 'Federation' has been written and repeated over and over again. A perusal of the report of that Conference will, however, suffice to show what was necessary to enable the Chairman to efficiently perform his function. That Mr. Ward possessed all the essential qualifications for the performance of his arduous task was made evident throughout that day. The dignity, tact, and business capacity which characterised his conduct in the chair won for him the unanimous plaudits of the assembled delegates.

The unconstitutional organisation, which during the period ranging from January 1892 to October 1893, represented the Assistant Teachers of the country, is now a thing of the past, and its place is taken by a well organised and properly constituted body. That the National Federation of Assistant Teachers has done and is now doing most useful work is acknowledged on all sides. The honour of presiding over the Conference which brought the Federation into existence is an unique one.

At the Derby Conference Mr. Ward was elected to the position of Treasurer to the Federation, and it is no mean tribute to his ability that at the recent Conference of Assistant Teachers held at Birmingham he was re-elected to the position without any opposition.

Locally, Mr. Ward is well known in connection with the Assistant Teachers' questions. The Nottingham Assistant Teachers' Association, which is one of the oldest in the country, claims him as one of its first members. He has served on the committee, acted as secretary, and in 1891 occupied the position of president.

We drew from him several opinions which we think worthy of special notice. Chief among these was the following:—

'I believe that the chief aim of any organisation which consists of Assistant Teachers, should be to remove the false and uneducational position in which the Class Teachers of the country are now placed. As a Certificated Teacher I am recognised by the authori-

ties as possessing the power and ability to teach. But, along with my colleagues, I am branded with the term 'Assistant,' and the man in the street regards me as a member of an inferior order in the pedagogic profession. My ideal is to make the Certificated Class Teacher complete master over his class. Each class should in itself be a little school. What affects the school as a whole should concern the Principal Teacher; but with what affects an individual class I maintain he has nothing whatever to do.'

'But,' we suggested, 'that idea would be difficult to carry out.'

'Not at all,' was the reply, 'if you would adopt the system of placing a Teacher in charge of a class, with which he should remain throughout the whole of the children's school lives. Give a Teacher Standard I., for instance. He should remain with those scholars throughout all the Standards. The essence of true teaching lies in the Teacher's influence being exercised upon each of his pupils. Look at the amount of waste energy, to say nothing of time, expended year after year by a Teacher who is placed in charge of different classes. The disposition, character and individual attainments of each child must be known before true tuition can commence, and every year time and labour must be spent to acquire this knowledge.'

'Then,' we again interposed, 'you are satisfied that every Certificated Teacher is competent to undertake the duties which you would place upon him?'

'If he is not,' said Mr. Ward, 'he must decidedly give place to those who are, but we must have Inspectors who are capable of judging his competence, and on them should rest the responsibility of his dismissal. Further, the Teacher should possess the right of appeal to the Department. The Assistant Teacher's position today depends too much on the whims and caprice of Head Teachers. I think I have outlined a remedy for this. Every class ought to be in charge of a Certificated Teacher.'

Changing the subject, we referred to the Assistants' Federation. Mr. Ward expressed a very high opinion of the value of this organization to its members. He does not anticipate the adoption of any policy by the assistants which will be antagonistic to the N.U.T. so long as the interests of Assistant Teachers are guarded by the Union. He believes that the right hand of fellowship should be extended to the Federation by the N.U.T. because of their common interests.

Speaking upon the matter of the Assistant Teachers' representation on the Executive of the N.U.T., Mr. Ward said:—

'It is, of course, obvious that the Assistant is not adequately represented. Representation depending upon membership makes it essential that every Assistant should join the Union. Whilst speaking of the Executive I should like to add that it would be better if the members of the Union would take a more intelligent interest in the matter of their representation. I am not at all sure that every member of the Executive performs his due share of the work, and those who either cannot or will not do so should give place to those who will.'

Speaking generally upon Union policy, Mr. Ward stated himself to be in favour of an extension of the Union's operations on Trades' Union lines. He strongly advocates Parliamentary representation, and approves of the suggestion to award pensions to the Union officials. He believes that the question of Rate Aid to Voluntary Schools is not one which should come within the scope of the Union's action.

The most important questions before the profession at the present time should be the establishment of a 'living wage' and greater security of tenure.

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TEACHERS' DRAWING LESSONS.

MODEL.

STANDARD VI.

BY E. BUFFERY RIDGE,

Art Master under the London School Board.

Table.—A plain kitchen table with square legs is the best for this purpose. Draw a horizontal line at the eye-level, and measure the distance *st* from this line to the front corner of the table, and from *t* down to the floor at *a*. Fix all other lengths by comparison with *ta*. Sketch the top of the table (showing the thickness), but as its height above the floor is probably greater than that of the board previously used, care must be taken not to get the width from front to back too great. Fix a plumb-line to the nearest corner and mark *a*, the point at which it reaches the floor. Draw *abcd* by vanishing lines, mark *e*, the nearest corner of the nearest leg, and inside *abcd* draw two similar rectangles showing at their intersecting corners the bottom ends of the legs as four small squares.

Now suppose the legs to penetrate the top of the table. Four small squares would be seen. Mark *f* the nearest corner of the nearest square, and obtain the top ends of the legs in the same manner as the bottom ends. Sketch lightly the three edges of each leg which would be seen. Notice if the proper length of the back leg, seen under the table, is shown in the drawing. If not, the fault is probably in the top of the table—the length and width not being drawn in correct proportion. If the table has round or turned legs it is still advisable to sketch it in the way described for square legs, drawing the legs afterwards as shown on the right of the figure.

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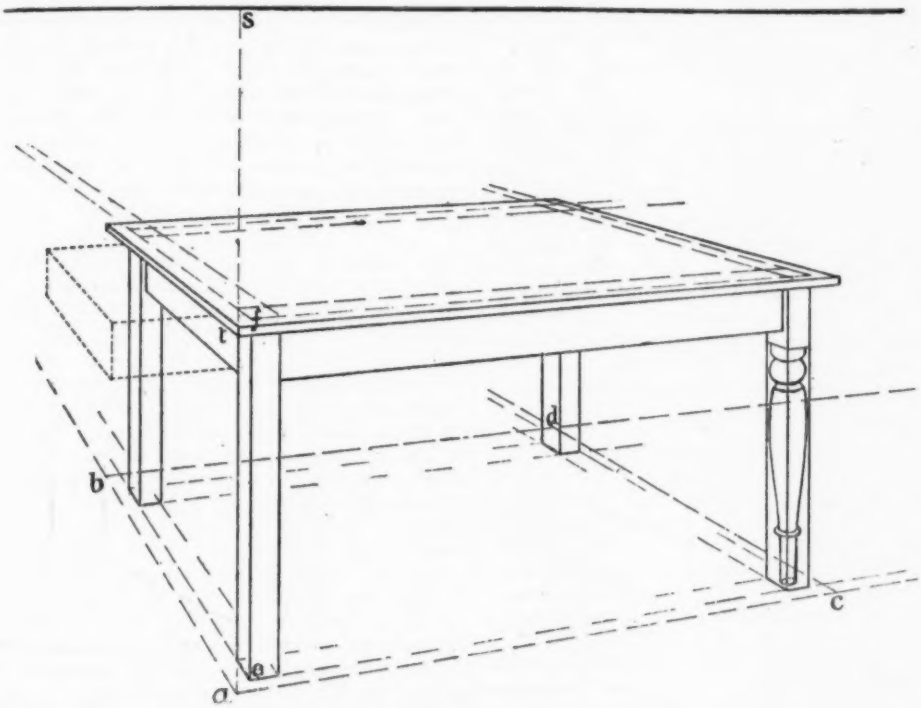

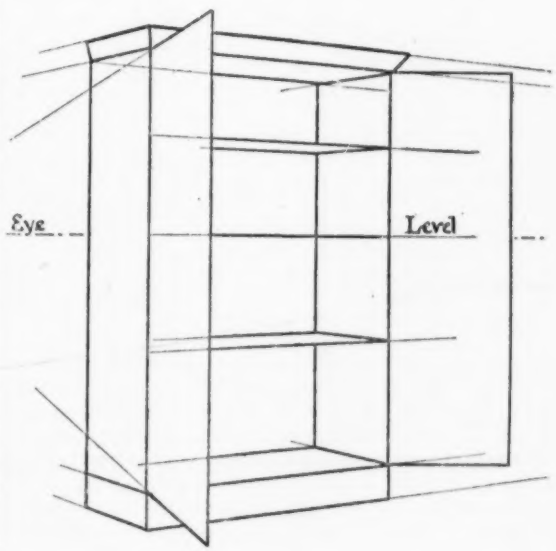

ties as possessing the power and ability to teach. But, along with my colleagues, I am branded with the term 'Assistant,' and the man in the street regards me as a member of an inferior order in the pedagogic profession. My ideal is to make the Certificated Class Teacher complete master over his class. Each class should in itself be a little school. What affects the school as a whole should concern the Principal Teacher; but with what affects an individual class I maintain he has nothing whatever to do.'

'But,' we suggested, 'that idea would be difficult to carry out.'

'Not at all,' was the reply, 'if you would adopt the system of placing a Teacher in charge of a class, with which he should remain throughout the whole of the children's school lives. Give a Teacher Standard I., for instance. He should remain with those scholars throughout all the Standards. The essence of true teaching lies in the Teacher's influence being exercised upon each of his pupils. Look at the amount of waste energy, to say nothing of time, expended year after year by a Teacher who is placed in charge of different classes. The disposition, character and individual attainments of each child must be known before true tuition can commence, and every year time and labour must be spent to acquire this knowledge.'

'Then,' we again interposed, 'you are satisfied that every Certificated Teacher is competent to undertake the duties which you would place upon him?'

'If he is not,' said Mr. Ward, 'he must decidedly give place to those who are, but we must have Inspectors who are capable of judging his competence, and on them should rest the responsibility of his dismissal. Further, the Teacher should possess the right of appeal to the Department. The Assistant Teacher's position today depends too much on the whims and caprice of Head Teachers. I think I have outlined a remedy for this. Every class ought to be in charge of a Certificated Teacher.'

Changing the subject, we referred to the Assistants' Federation. Mr. Ward expressed a very high opinion of the value of this organization to its members. He does not anticipate the adoption of any policy by the assistants which will be antagonistic to the N.U.T. so long as the interests of Assistant Teachers are guarded by the Union. He believes that the right hand of fellowship should be extended to the Federation by the N.U.T. because of their common interests.

Speaking upon the matter of the Assistant Teachers' representation on the Executive of the N.U.T., Mr. Ward said:—

'It is, of course, obvious that the Assistant is not adequately represented. Representation depending upon membership makes it essential that every Assistant should join the Union. Whilst speaking of the Executive I should like to add that it would be better if the members of the Union would take a more intelligent interest in the matter of their representation. I am not at all sure that every member of the Executive performs his due share of the work, and those who either cannot or will not do so should give place to those who will.'

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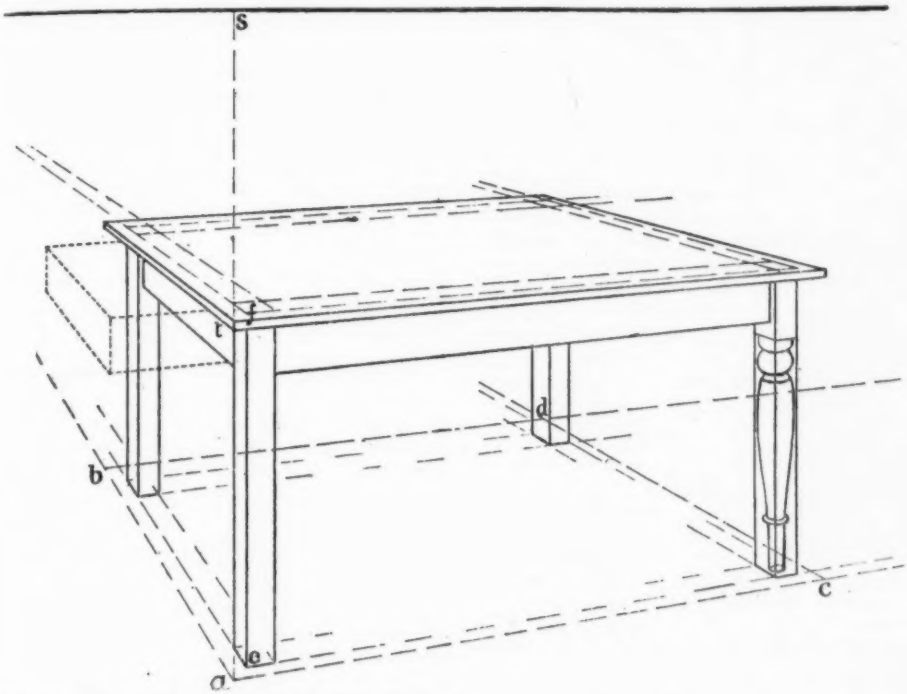

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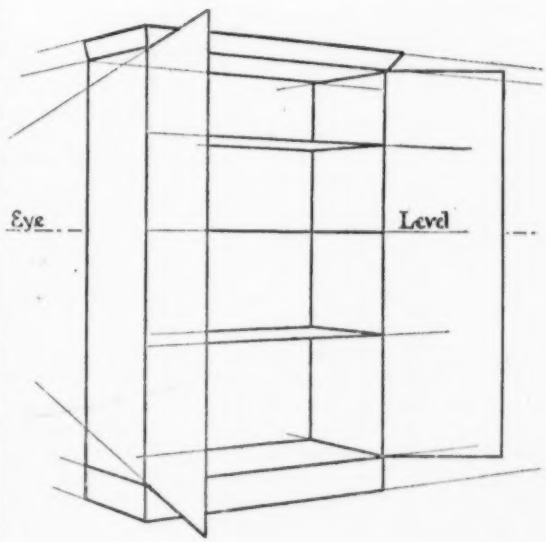
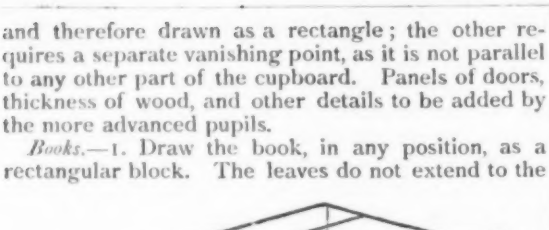
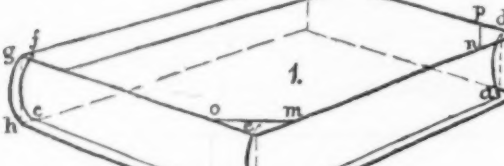


and therefore drawn as a rectangle; the other requires a separate vanishing point, as it is not parallel to any other part of the cupboard. Panels of doors, thickness of wood, and other details to be added by the more advanced pupils.

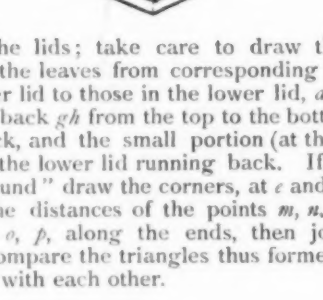
Books.—1. Draw the book, in any position, as a rectangular block. The leaves do not extend to the



edges of the lids; take care to draw the curved corners of the leaves from corresponding points *def* in the upper lid to those in the lower lid, *abc*. Draw the curved back *gh* from the top to the bottom corner of the block, and the small portion (at the opposite corner) of the lower lid running back. If the book is "half-bound" draw the corners, at *e* and *d*, by first marking the distances of the points *m*, *n*, along the front, and *o*, *p*, along the ends, then joining the points. Compare the triangles thus formed with the model and with each other.



2. Use an upright line to fix each of the curves across the back.



3. Vanishing lines for the curves of the back. *ab* equal to *cd*.

NOTES AND NOTIONS.

BY RICHARD WADDINGTON.

'Er Charley,—well,—there cannot be
Another pate like his,—
It's o' crom-full o' ancientry,
An' Roman haw-pennies!'

And, if the present mania for increasing the obligatory subjects does not receive its quietus, specimens of 'Er Charley' will be too plentiful to merit the notice of the poet. The bitter cry of 1884 will be repeated ere we reach 1904 if the theorist is to be at liberity to add to the burdens of teacher and taught. The last straw! Why, it's a whole bundle of straws! Increased drawing requirements, varied occupations, object lessons, and physical exercises. How inadequate must have been the task hitherto if all these can be added without some relief in present requirements! The following warnings in the Code might be taken as a practical joke but for the too solid experience of the past, which places practical joking outside the blue covers of a Code:

1895 increased work.
1896 „ staff.

One wonders, really, whether Mr. Gilbert has been on a visit to Whitehall. There is such a Gilbertian topsy-turvydom about these two paragraphs that it is hard to believe they are not a cruel joke.

* * * * *

Object lessons, varied occupations, and physical exercises will be admirable when there's time and teaching staff. But you see there's the three sums right out of four, one of which must be a problem; there's the ·0001 mistakes per child in spelling to be obtained,—and there's one out of every five of the children away every time the school opens, without mentioning the single-handed teacher struggling with the seven standards and the infants. And where does it all end? At eleven years of age, just when the child is beginning to learn, the certificate of having reached the fourth standard is forthcoming and the teacher's efforts are dissipated in the gutter. Truly, the legislature means business in matters educational when it only means adding a few obligatory and additional subjects to the fixed grant or the eighteenpennyworth of discipline and moral training.

* * * * *

I am indebted to the 'Attendance Officer and School Gazette' for the following:—

Teaching the young idea how to shoot.—A brawny farmer presented himself at a country school, dragging an overgrown boy reluctantly through the door. 'What's yer limit here? This boy's arter an iddicashun,' he demanded. The timid teacher replied that the curriculum 'embraced reading, arithmetic, history, algebra, trigonometry—' 'That will do,' interrupted the farmer. 'Load him up heavy with triggernometry; he's the only poor shot in the family.'

* * * * *

The Conference of Assistant Teachers—one hardly knows whether Class Teachers is orthodox—did good work at Birmingham. Mr. Allen Croft's address was worthy of the man and the occasion. Dignified, eloquent, and withal pungent, the address is bound to do good in the metropolis of the Midlands. The whole of the Conference proceedings must do much to place the Assistant in true perspective in the eyes of the public. I congratulate Mr. Croft and the Federation. The sowing of wild

oats ended at Derby. I hope to congratulate Mr. Croft next Easter on his election to the Executive of the N.U.T. That he would do good work for all teachers I have not a shadow of doubt. Mr. Jackman's paper on Large Classes was brimful of solid facts. Mr. Jackman never lets his case go for want of well-arranged facts. When at the Executive he fails to array convincing columns of statistics it is taken for granted there are none to be had. In revising Article 73 the Department might well digest Mr. Jackman's figures—they need attention.

* * * * *

In the list of candidates selected to represent the Federation at the Executive election there is no mention of the intention to nominate a mistress. Why? Has this very desirable object been relegated to the far-distant future? Are the mistresses content to allow their claims to representation to go by default? I hope the London Committee will keep this in mind when they select their quota.

* * * * *

Here is the description of a school by H.M. Inspectors in the early fifties. Surely a 'Fabric Circular' was wanted then:—

> Not far from this infant asylum I entered a common school. It was a room on the ground floor, up a dark and narrow entry. Here 43 boys and girls were assembled, of all ages, from 5 to 14. Patches of paper were pasted over the broken panes of the one small window, before which sat the master, interrupting the few rays of light which would otherwise have crept into the gloom. Although it was in August, the window was closed, and a fire added to the animal heat which radiated from every part of the crowded chamber. In front of the fire, as near to it as a joint on the spit, a row of children sat, with their faces towards the master and their backs to the furnace. By this living screen the master, though perspiring copiously, was somewhat sheltered from the intolerable heat. As another measure of relief amidst the oppression of the steaming atmosphere, he had also laid aside his coat. In this undress he was better able to wield the three canes, two of which, like the weapons of an old soldier, hung conspicuously on the wall, while the third lay on the table ready for service. When questioned as to the necessity of this triple instrumentality, he assured us that the children were 'abrupt and rash in their tempers,' that he generally reasoned with them respecting their indiscretions, but that when civility failed he had recourse to a little severity. There was no classification of the children, and the few books in the school were such as the parents chose to send. Under such circumstances the poor man had an arduous task to accomplish, and not knowing what situations might not be in our gift, he informed us that he would gladly avail himself of any opportunity of quitting an employment to which extravagance alone had caused him to descend.

* * * * *

Mr. Pope's address to the Head Teachers of the London Board Schools is a fearless demand for liberty in the schools. Did space permit I would reprint very largely, 'Recent and Proposed Additions to School Work and Worry':—

> As long as we have the set annual examination, says Mr. Pope, as the gauge of the work done in a year, so long shall we have our national game played in the schools. The Inspectors are out and we are in. They bowl and field and shout 'How's that,' whilst we use all our art and skill to keep in as long as we can. Any way we are always in danger. Some of us are clean bowled, some are caught, some are run out, some are given out leg before; and, I fear, some know what it is to be umpired out. All this is not as it should be; and the sooner it comes to an end the better for all concerned. And again queries Mr. Pope, Why should H.M. Inspector want to know of a lad in Lewisham the circumference of the Kauri pine, or the range of hills between the Findhorn and the Spey? Why should the grammar in our schools be as detailed as that for the Queen's Scholarship Examination?

And fifty thousand Teachers are daily asking 'Why?' Well might Mr. Pope repeat the advice of the working man of Brighton, who advised teachers to take a little of the starch out of their collars and rub it into their backbones.

* * * * *

The Tenure Problem goes apace. No sooner is one case ended than another appears. The Barrow case has come to a happy termination. Mr. Helm is retained, and I hope matters will go on smoothly. Unwittingly these cases are doing a vast amount of good. Such cases as the one at Barrow are invaluable in the agitation for Reasonable Security of Tenure. A word of well-merited praise is due to the officials of the Barrow Association. The way they stood by Mr. Helm is invigorating to contemplate. And Mr. Organ. There can be no doubt about the astute and able manner in which the Law Clerk conducts the cases, when it is borne in mind that the Union has never yet had to defend an action for libel, and when it is remembered that serious charges have been made, which, if untrue, would meet with salutary admonition at the hands of any judge. It is a tribute of no light magnitude to the care and judgment of the Law Clerk, as well as the Law Committee of the Union.

* * * * *

There can be no doubt that the Drawing requirements are felt to be excessive. So long as the large majority of schools did not reach the work of the Upper Standards the complaint was by no means universal; but now, in nearly every school, there are scholars in the Fifth and Sixth Standards. Herein lies the difficulty of the present requirements.

* * * * *

None too soon have the Executive of the N.U.T. decided to press on the Science and Art Department the necessity for revising the demands, especially in the Upper Standards. Not long ago, the same work which is now required of a Sixth and Seventh Standard scholar would have sufficed to obtain Second Grade passes, if not 'Excellents' in Freehand, Model, and Geometry. I am not by any means an old man. In fact, I have not yet reached half the allotted three score and ten years. But, when I obtained my 'D.,' such were the requirements, that a good Sixth Standard boy of to-day could with ease have met three out of the five requirements and produced no better work than is now required. No doubt we English are a curious race. We go for Drawing, and we go with a rush. The pace is simply ludicrous. The teaching of the Upper Standard Drawing requires as much ability, and as much industry, as the teaching of Reading, Writing, and Arithmetic. The Executive's suggestion is that not more than two subjects should be required in any one standard. In the Fourth Standard the scale should be simplified, and that the Geometry of the Fifth should be transferred to the Sixth, and the Solid Geometry of the Sixth should go to the Seventh.

* * * * *

That the grant for Drawing is utterly inadequate, every Practical Teacher knows. If this is true in large schools, how true it must be in small schools where under present arrangements a ten shilling postal order too often covers the amount received. Only an English Department of Education would aid a small and large school at the same amount per scholar. The matter is so absurd that a 'population'

grant is devised to right a grave anomaly. The Executive suggest a graduated scale of grants. The smaller schools to have a grant of 5*s.* or 6*s.* per unit, and the larger schools 3*s.* or 4*s.*

* * * * *

The work of the Executive of the N.U.T. is no light task, and during this year it has been heavier than of yore. Two familiar faces were absent from the last meeting—Messrs. Wild and Walker are unfortunately laid aside. I am sure every teacher in the land wishes them speedy recovery. The debt due to Mr. Wild for his long devotion to the Union cannot be lightly estimated, and the same is true of Mr. Walker.

* * * * *

The question must occur, 'Are our present arrangements the best?' The work cannot get lighter. What was sufficient for a Union ten thousand strong may not be sufficient for a Union nearly thirty thousand strong. We must come to some system of devolution. Take the case of a country member of the Executive. He leaves school at 4.30 on Friday afternoon for London, arriving about 10 the same night. This occurs twice a month. The Executive rises too late for the return journey to be made on Saturday, and Sunday is spent in returning. Much more than this he cannot do, and he cannot do this long. One marvels at the enthusiasm and physical resource of Mr. Bowden, who at 10.30 p.m. on Saturday rushes off to catch the night train to Gateshead. The time is arriving when the Conference must seriously consider the resolution sent up from Manchester that the country be divided into four divisions, with an Executive Council in each.

* * * * *

Possibly we should begin with two or three districts at the first. This would mean the appointment of paid organisers in each division. But I am not sure that the result would be a great financial burden. Everyone acquainted with Union organisation is aware what useful work could be done by a paid organiser. The increase of membership, to say nothing of the reduced travelling expenses, would go a long way to meet the cost. The local influence of the Union would be greater. Without fear, the organiser could champion the cause of the teacher throughout the district. Even in the matter of School Board Elections, much could be done to shed light on the position of both Voluntary and Board teachers. The subject deserves the attention of Conference, and I feel sure will ere long force itself to the front in a manner not altogether to be desired, unless a sudden change comes o'er the present excessively long meetings of the Executive.

* * * * *

Dare I mention the Executive's Scheme for further Financial Aid? Well, it is pleasing to find the Executive in 'hot water.' For weal or for woe the Executive has gone for State-aid in preference to Rate-aid. It is purely a question of expediency. In my March contribution, I pointed out that in my opinion State-aid was preferable. Rate-aid would only assist schools where a rate exists. Thus, its influence would only be partial in its effect. And many of the schools where no rate exists want help. Then again, in the majority of districts, the present rate would have to suffice for both Board and Voluntary Schools. This would mean a reduction of the efficiency of the Board Schools, and consequently, a corresponding lowering of the Voluntary Schools. But Voluntary Schools could not share the rates and remain Voluntary Schools, I feel sure. At the Election of the School Board, the ratepayers would make that clear. Many of the Board Schools are as badly off as the Voluntary Schools. Take the places with a low assessment. The smallest expenditure is apparent on the rate. Is nothing to be done for these schools?

NEW PROBLEMS IN ARITHMETIC.

BY T. B. ELLERY, F.R.G.S.,
Vice-President National Union of Teachers.

3RD PAPER.

For introduction, *see* October No. of *The Practical Teacher*. For other remarks on the same subject I refer my readers to the *Girls' Mistress* for September 1st, in which appears the first of a series of papers on *Standard Problems for Girls, and How to Work them*. In passing let me say:—

1. Every exercise here given will suggest to the practical teacher many others of the same kind.
2. The blackboard should be freely used in the solution of these problems.

STANDARD 5.

A.

1. How many more oranges at 9d. a dozen can be bought with 115 crowns than with 178 florins?

2. I buy £55 10s. 8d. worth of butter at the rate of 130s. 8d. per cwt. I sell one half of it at 1s. 6d. per lb. and the remainder at 1s. 3d. per lb. Find my gain.

3. 15 horses are worth 18 cows, and 3 cows cost £52 12s. 6d. What will 20 horses cost?

4. 14 dresses are made out of cloth costing £4 7s. 6d. At the rate of 6d. a yard how many yards were there in each dress?

5. I bought 18 cows and 12 ponies for £420, a cow costing as much as 2 ponies. What was the cost of a cow?

6. I bought 16 pigs and 15 sheep for £123 7s. 6d., 2 sheep costing as much as one pig. Find the total cost of a pig and a sheep.

7. I bought a cask of sugar weighing in all 3½ cwt. (16 lb. for the cask) for £1 19s. 4d. At what price per lb. must I sell the sugar so as to gain 15s. 6d. altogether?

8. A man spent ⅔ of his holiday in London, and ½ in Brighton. The rest (3 days) he spent in the Isle of Wight. How many days' holiday had he?

9. $\frac{1}{8}$ of an estate is worth £2,176 8s. 6d. Find the value of $\frac{1}{15}$ of it.

10. A draper bought 120 pairs of gloves for £13 10s. A certain number of pairs faded and could

not be sold, and the rest he sold at 3s. 4d. a pair, and received £18 16s. 8d. How many pairs were unsaleable?

11. 24 men can do a piece of work in 16 days. How many additional men must be put on in order to complete the work in 12 days?

12. A 4d. loaf weighs $2\frac{1}{2}$ lb. when wheat is 39s. a quarter. What will it weigh when wheat is 26s. a quarter?

B.

13. £7 17s. 6d. is divided between a man and a woman, the latter receiving half as much again as the former. Find the woman's share.

14. A fruiterer spent 4 guineas in peaches at 1s. a score, and he sold them at 1s. a dozen. Find his gain.

15. A man spent $\frac{1}{3}$ of his money and then $\frac{1}{2}$ of what remained. He had then $2\frac{1}{2}$ guineas. How much had he at first?

16. If $2\frac{3}{4}$ acres be divided among 7 men and 8 women, each man receiving twice a woman's share, how many square yards will each man receive?

17. A boy bought a bicycle, his father paying $\frac{1}{7}$ of the total cost, the boy paying the remainder ($1\frac{5}{7}$ guinea). What did the father pay?

18. A grocer bought $1\frac{1}{2}$ cwt. of sugar at a penny per lb., and $\frac{3}{4}$ cwt. at $1\frac{1}{2}$d. per lb. He sold the whole at the rate of 4 lb. for 6d. Find his gain.

19. $\frac{1}{3}$ of the passengers by a certain train travelled 2nd class, and $\frac{1}{4}$ 3rd class. There were 18 in the 1st class carriages. How many passengers in all?

20. A fishmonger bought 2,500 herrings at 100 for 6d. He afterwards threw away 1 out of every 5 as being unfit for sale. How many of the remainder must he sell for 1s. so as neither to gain nor lose on the whole?

21. A had $\frac{1}{3}$ of an estate, and B the remainder. The difference in the value of their shares was $1,360\frac{1}{2}$ guineas. What was the value of the estate?

22. A grocer mixes chicory which cost him 6d. per lb. with coffee which cost him 1s. 3d. per lb. Find his gain when he mixes 2 lb. of chicory with 9 lb. of coffee, and sells the whole at 1s. $5\frac{1}{2}$d. per lb.

23. A train leaves a certain station at 8.30 a.m., and travels at the rate of 32 miles 4 furlongs an hour. Another train leaves the same station half-an-hour later, and travels in an opposite direction at the rate of 40 miles an hour. How far will they be apart at midday?

24. A grocer bought 2 cwt. of tea for sixteen guineas. He sold 84 lb. at a loss of 4d. per lb., and the remainder at a gain of 6d. per lb. Find his total gain.

25. Half-a-dozen shirts can be made out of 21 yards of flannel. How many shirts can be bought for £6 2s. 6d. at 6d. per yard?

C.

26. A can do a piece of work in 6 days, and B in 12 days. If they work together, in what time will they complete the task? [Note. A can do $\frac{1}{6}$ in 1 day and B $\frac{1}{12}$.]

27. A and B can do a piece of work in 8 days, which A alone can do in 12 days. How long would B take working alone?

28. If 14 cows or 21 sheep can clear a field in 9 days, how long will 20 cows and 24 sheep take to clear it? [Work with sheep only: 14 cows = 21 sheep; ∴ 20 cows = 30 sheep.]

29. X walks at the rate of 3 miles an hour, and Y at the rate of $3\frac{1}{2}$ miles an hour. X starts at 9.30 a.m., and an hour later Y starts to overtake him. At what time will X be overtaken? [Note. When Y has *gained* the start X had, the two will be together.]

30. A man had an estate of 48 acres of land. He sold $\frac{1}{8}$ of it, and then divided the rest into 24 allotments of equal size. Find the rent of one of these at three guineas per acre.

31. A man spent $\frac{1}{4}$ of his money and then $\frac{1}{3}$ of what remained. He had then 20 guineas left. What had he at first? [Note. After spending $\frac{1}{4}$ $\frac{3}{4}$ remains, and $\frac{1}{3}$ of $\frac{3}{4}$ is $\frac{1}{4}$.]

32. Two equal sums of money were divided among 53 men and a certain number of women. Each man received £1 8s. 6d., and each woman a florin less. How many women were there?

33. A draper paid £12 15s. for gloves at 2s. $1\frac{1}{2}$d. a pair. Some of these faded and were not sold, and for the remainder he received £15 10s. $7\frac{1}{2}$d. at 2s. $11\frac{1}{2}$d. a pair. How many pairs were unsold?

34. A bankrupt pays 6s. 3d. in the £, and pays in all £375. What are his debts? [Note. £1 is the debt on which he pays 6s. 3d.]

35. A man pays £5 10s. 10d. income tax at the rate of 7d. in the £. He does not pay on the first £160 of his income. Find his total income. [Note. First find income *on which he pays the tax*. Then add the £160.]

36. A man has £213 11s. 8d. remaining after paying income tax on £220. What is the tax in the £? [Note. The tax on £220 is £220 − £213 11s. 8d.]

37. I pay 7d. in the £ income tax, and have £349 10s. remaining after the tax is paid. What is the income on which I pay? [Note. After paying tax on £1 there is 19s. 5d. remaining.]

38. A garrison has provisions to last 600 men for 32 days. At the end of 8 days 240 men are sent away. How long will the provisions last the remainder? [Note. 32 − 8 = 24 days; 600 − 240 = 360 men.]

39. A farmer bought 122 sheep for £227 16s. 6d. Two died, and the total expenses for food amounted to £4 13s. 6d. At what price must he sell each of the remainder so as to gain £18 10s. on the whole transaction? [Note. Total cost = £227 16s. 6d. + £4 13s. 6d. To obtain total selling price, add proposed gain to this amount.]

40. The sum of two hundred pounds is divided among 6 men, 4 women, and 8 boys, each boy receiving one half a woman's share, and each woman one half a man's share. Find a man's share. [Note. 1 man = 2 women = 4 boys; ∴ 6 men = 24 boys; 1 woman = 2 boys; ∴ 4 women = 8 boys. Work the sum with boys only.]

41. A takes 16 hours to walk 48 miles. B can cover the same distance on his tricycle in 8 hours.

They start at 10.30 a.m. at opposite ends of the journey to meet each other. At what hour will they meet? [First find rate per hour for each. Then find how many miles they together cover in 1 hour.]

42. A train leaves King's Cross, London, at 8.30 p.m., and reaches Glasgow at 7.55 the next morning. The distance is 441 miles. Find the rate of running per hour, allowing 55 minutes for stoppages on the way. [Deduct stopping time to find actual running time.]

NEW PROBLEMS.—ANSWERS.

(1) 292 dozen (OR 3,504) oranges.
(2) £9 18s. 4d.
(3) £421.
(4) 12½ yards.
(5) £17 10s.
(6) £7 17s. 6d.
(7) 1⅞d.
(8) 24 days.
(9) £1,450 19s.
(10) 7 pairs.
(11) 8 *additional* men.
(12) 3⅜ lbs.
(13) £4 14s. 6d. woman's share.
(14) £2 16s. gain.
(15) £10 10s.
(16) 1,210 sq. yards.
(17) £12 17s. 3d.
(18) 8s. 9d. gain.
(19) 144 passengers.
(20) 160 herrings.
(21) £2,857 1s.
(22) 3s. 9½d. gain.
(23) 233⅓ miles.
(24) £2 2s. gain.
(25) 70 shirts.
(26) 4 days.
(27) 24 days.
(28) 3½ days.
(29) 3.30 p.m.
(30) 15s. 9d.
(31) £63.
(32) 57 women.
(33) 15 pairs.
(34) £1,200.
(35) £350.
(36) 7d.
(37) £360.
(38) 40 days.
(39) £2 1s. 10d.
(40) £20 man's share.
(41) 3.50 p.m.
(42) 42 miles per hour.

QUERY COLUMN.

J.S.—Two men start at the same time towards one another. They pass after the slow man has walked 8⅓ miles. The faster walker reaches the starting point of the other in 4 hours 12 minutes, then turns back and overtakes him in 7 hours more. Find the rates of travelling, and the distance between the starting points.—(*Civil Service.*)

Let A be the faster walker, and B the other.

Then A's rate : B's rate :: 11½ hours : 7 hours
:: 56 : 35
:: 8 : 5

Also A's rate : B's rate :: Distance — 8⅓ miles : 8⅓ miles ;
∴ Distance — 8⅓ miles : 8⅓ miles :: 8 : 5.
5 (Distance — 8⅓ miles) = 8⅓ miles × 8,
Distance — 8⅓ miles = $\frac{25}{3}$ miles × $\frac{8}{5}$
= $\frac{40}{3}$ miles
= 13⅓ miles.
∴ Distance between the starting points
= 13⅓ miles + 8⅓ miles
= 21⅔ miles. Ans.

A's rate per hour = Distance ÷ 4½
= 21⅔ miles ÷ $\frac{9}{2}$
= ($\frac{65}{3}$ × $\frac{2}{9}$) miles
= $\frac{130}{27}$ miles
= 5$\frac{5}{27}$ miles. Ans.

B's rate per hour = $\frac{3}{5}$ of B's rate
= ($\frac{130}{27}$ × $\frac{3}{5}$) miles
= $\frac{390}{135}$ miles
= 2$\frac{26}{27}$ miles. Ans.

S.S.C.—A's farm and B's farm together measure 27 acres 10 poles ; B's and C's 29 acres 2 roods 20 poles ; C's and A's 28 acres 3 roods 30 poles. What is the share of each?—(*3rd Year P.T.'s, Females.*)

By adding 27 acres 10 sq. poles, 29 acres 2 roods 20 sq. poles, and 28 acres 3 roods 30 sq. poles, we get 85 acres 2 roods 20 sq. poles.

Now this equals twice A's + twice B's + twice C's.
∴ A's, B's and C's = 85 acres 2 roods 20 sq. poles ÷ 2
= 42 acres 3 roods 10 sq. poles.
∴ A's farm = 42 acres 3 roods 10 sq. poles — 29 acres 2 roods 20 sq. poles
= 13 acres 30 sq. poles.
B's farm = 42 acres 3 roods 10 sq. poles — 28 acres 3 roods 30 sq. poles
= 13 acres 3 roods 20 sq. poles.
C's farm = 42 acres 3 roods 10 sq. poles — 27 acres 10 sq. poles
= 15 acres 3 roods.

J.M.—Compare the relative advantages of the following investments. A gas company guarantees 5% on shares of £100 each ; a railway company offers 4⅝% on shares of £7 10s. each. The price of the former is £124 10s , and of the latter £8 10s.

Gas company : railway company
:: $\frac{5}{124\frac{1}{2}}$: $7\frac{1}{2} \times \frac{4\frac{5}{8}}{100}$;
:: $\frac{10}{249}$: $\frac{\cancel{15}}{17} \times \frac{29}{\cancel{2}} \times \frac{1}{\cancel{100}}$;
:: $\frac{10}{249}$: $\frac{29}{680}$;
:: 6800 : 7221.

Ralpho.—(*a*) Find the angle between the lines $4r\cos\theta + 3r\sin\theta = 1$, $r\cos\theta = 3$.

(1) $4r\cos\theta + 3r\sin\theta = 1$
(2) $r\cos\theta = 3$
Put $x = r\cos\theta$
And $y = r\sin\theta$
(1) $4x + 3y = 1$
(2) $x = 3$
(1) $3y = -4x + 1$
$y = -\frac{4}{3}x + 1$.

The tangent of the angle between the straight lines
$y = m_1 x + c_1$
and $y = m_2 x + c_2$
$= \frac{m_1 - m_2}{1 + m_1 m_2}$.

In the given straight lines
$m_1 = -\frac{4}{3}$
$m_2 = 0$
∴ Tan. of angle = $\frac{-\frac{4}{3}}{1}$
= $-\frac{4}{3}$.
∴ Angle is between 120° and 135°.

LEGAL AND CODE QUERIES COLUMN.

RULES.

1. All communications must be addressed 'Legal Editor, PRACTICAL TEACHER, Froebel House, St. Andrew's Hill, Doctors' Commons, E.C.,' and must be accompanied by our 'coupon,' duly filled up.
2. Replies will be given *only* in this column, except under the conditions named in Rule 3.
3. If any reader desires a reply by post, such can be forwarded by enclosing, in addition to the coupon, a stamped addressed envelope and either stamps or a Postal Order to the value of one shilling.

4. No original documents should be forwarded, but copies only. We cannot hold ourselves responsible for any losses which occur through non-observance of this rule.

Copyright Law.—'ONYX.'—(1) The Act at present in force (5 and 6 Vict. c. 45) fixes copyright at 42 years, *or* the period of the author's life, plus 7 years, whichever period is the longer. (2) You should write to the publishers of the particular reading book on the matter.

'Rector' and 'Vicar.'—'GEORGE.'—George asks, 'What is the difference between a Rector and a Vicar?' All church benefices may be classified under two heads—(1) appropriated, (2) impropriated. Each benefice has an incumbent who has charge of the parish, or, as it is technically termed, the 'cure or care of souls.' Each incumbent is either a rector or vicar, a vicar having charge of an appropriated benefice, and a rector of a non-appropriated benefice. For the origin of the difference between benefices we should need a historical essay. As matters stand at present in an appropriated benefice, the property of such benefice does not belong directly to the vicar, but often to a lay person, who assigns to the vicar either all or a portion of the tithes, etc. In the case of the rector, who has charge of a non-appropriated benefice, the property belongs to him, and the tithes, rent of glebe land, etc., are paid to him, as his own right.

Breach of Promise.—'T. R. M.'—You appear to have a good case. Obtain from him a definite statement as to his intentions, and if not satisfactory consult a local solicitor.

Landlord and Tenant.—'LEASEHOLDER.'—Yes, you can deduct tax at the rate of 8d. in the £.

Scholarship Examination.—'JAMES.'—The Education Department have stated officially that 'the marks for Reading, Recitation, and Teaching, awarded in anticipation of the July Queen's Scholarship Examination, will also be accepted for next December.'

Can Women serve on Juries?—'N. L.'—Not under ordinary circumstances. A jury of matrons is occasionally summoned for a special purpose. If you are particularly anxious to know the exact circumstances under which such a jury may be empanelled, I will write you privately.

Pupil Teachers' Duties.—'H. N.'—(1) I am sorry your communication did not arrive early enough to enable me to reply in the November issue. (2) The managers magnify the nature of the offence considerably. If they dismiss you, your father should consult a good solicitor on the advisability of commencing an action to recover damages.

Army Schoolmasters.—'MISTRESS.'—If you wish your son to become an army schoolmaster, he should if possible first become a pupil teacher in one of the military schools. In order to do so he must be between the ages of 16 and 18, and must be successful at a competitive examination. The pay is as follows, with quarters, fuel, and rations, or an allowance in lieu:—

—	Pay.		Allowances per annum, when quarters, etc., are not provided.			
	Per day.	Per annum.	If permitted to draw allowances for lodging, and fuel and light at home stations, approximately.	If permitted to draw allowance in lieu of rations.	Approximate total per annum.
	s. d.	*£ s. d.*	*£ s. d.*	*£ s. d.*	*£ s. d.*
On first appointment -	4 0	73 0 0	31 13 7	9 2 6	113 16 1
	to		to		to
Increasing by 6d.* a day for every four years' service up to a maximum of	5 0	91 5 0	35 9 7	9 2 6	135 17 1
After 12 years' service as Schoolmaster, if re-engaged - - -	5 6	100 7 6	34 14 5	9 2 6	144 4 5
	to		to		to
Increasing by 6d.* a day for every four years' service up to a maximum of - - - -	7 0	127 15 0	38 10 5	9 2 6	175 7 11

* If the reports on their general conduct and of the management and progress of their schools have been satisfactory.

Change of Name.—'P. T.'—Lutetia was the ancient name of the city we now call 'Paris.' One authority thus accounts for the change: 'The Romans called it *Lutetia Parisiorum*, which literally translated means, the mud town of the Parisii. The former word being dropped, has left the present name Paris.'

Slander.—'G. H.'—The words used are not actionable, being mere vulgar abuse.

School Attendance.—'G. H. R.'—Yes, the law has been altered in two important respects, since July 1893, the date upon which I last referred to this subject. The present position of affairs may be thus stated:—

It is illegal to employ children under the age of 11 years. Children between the ages of 11 and 13 years must have passed the Standard fixed by the Local Bye Laws, either for partial or total exemption, before they can be employed. When a child between these ages has passed such Standard, he can be employed either full or half time, as the case may be, anywhere except in workshop, factory, or mine. With regard to the factory and workshop, no child under the age of 13 can be employed full time. When the age of 11 has been reached, he—*i.e.*, the child who has passed the requisite standard—may be employed half time in either of these places, but not full time, although he may have passed the full exemption Standard. He may be employed full time elsewhere, *but not in the factory or workshop.* This prohibition extends until he has reached the age of 13 years. After that age has been passed, the child can be employed full time in a factory or workshop, only if he has passed the fifth standard, or obtained the Dunce's Certificate. With regard to employment in a mine, no child can be employed until he reaches the age of 12 years, and then only when he has passed the Standard required by the bye-laws in force in the district.

OUR 1894 CERTIFICATE CLASS.

BY GEORGE BEACH, M.A., LL.D. (DUBLIN),

Author of '*Elements of English*,' '*A Girls' Arithmetic*,' '*Entertaining Readers*,' *etc.*

I. MISCELLANEOUS.

(*a*) In our Scholarship Article will be found a few rules or hints relative to the Examination itself. Instead of reproducing them we refer Certificate Candidates to them.

(*b*) The following circular speaks for itself :—

CIRCULAR TO RESIDENTIAL TRAINING COLLEGES.

Examination in Practical Skill in Music.

Education Department,
Whitehall,
London, S.W.

SIR,

In consequence of the shortened course of study of Second Year Students leaving Colleges in Midsummer, 1895, the following alterations will be made in the requirements in Practical Music :—

(*a*) Sight reading test will be simpler than usual ;

(*b*) Songs will not be required at the individual examinations ;

(*c*) No choral performances will be required from Students of either year, but the Inspectors will be prepared to hear such music if requested.

The above exemptions do not apply to Students in Day Training Colleges.

Please acknowledge receipt of this Notice on the annexed Form.

I have the honour to be, Sir,
Your obedient Servant,
G. W. KEKEWICH.

Training College.

II. HINTS ON LOGIC, ETC.

(*a*) *Habit* is that settled disposition, called forth by repeated exercise, which leads man to judge, to reason, to will, and to perform more and more mechanically in the same, or a similar manner, as heretofore.

(*b*) Habits must be :—

(1) (Allowing for circumstances) voluntarily acquired.

(2) The result of frequent repetition.

(3) Formed by acts having the same intent.

(4) Called into play by 'association of ideas.'

(*c*) School discipline may encourage habits by :—

(1) Influencing the will in their favour by means of pleasure and pain, and example.

(2) Afford opportunities for acts which create habits.

(3) Removing obstacles in the way of their formation.

(4) Encouraging, not merely one isolated right habit, but a *system* of right habits.

Habitual truth telling, sympathy, punctuality, cleanliness, politeness, may be established by judicious school discipline, if not unsettled by unfavourable indiscipline elsewhere.

(*d*) A perfect definition is one which unfolds the full connotation of the term and nothing else.

(*e*) The processes of thought involved in framing a perfect definition are :—

(1) Conception, or the power of forming a general notion.

(2) Comparison, or the power of detecting resemblances and differences.

(3) Abstraction, or the power of considering essential points by themselves.

(4) Generalisation, or the power of forming a class of similar things.

(*f*) *Example of a good definition.*

(1) 'Man is a rational animal.'

This is a good definition, because the genus *animal* is mentioned, and the essential difference, *rational*, is also given.

The word *animal* excludes all other beings, and the word *rational* excludes all other animals.

(2) '*Man is an animal*,' '*Man is a natural being*,' are obviously imperfect as definitions by reason of their breadth.

'*Man is a masculine rational animal*' is imperfect as being too exclusive.

(*g*) It is frequently desirable that definitions should be committed to memory, as—

(1) They summarise a certain amount of knowledge.

(2) They give permanent clearness of the essential ideas, and afford a test for classifying things.

(3) They are models which assist the mind to form for itself other definitions.

(4) *Ambiguity* is duplexity of meaning and vitiates a syllogism when it affects the middle term, *e.g.*,

Abstraction is a mental condition.
Picking pockets is *abstraction*.
∴ Picking pockets is a mental condition.

(*i*) *Convertible* terms are such as are exactly equivalent, so that one may be predicated of the other indiscriminately, *e.g.*,

'A human being is a rational animal' may be converted into 'A rational animal is a human being.'

Every perfect definition may be converted.

(*j*) A *categorical* proposition is one that simply asserts that an individual belongs to a species, a species to a genus, or a genus to the summum genus, etc.

Thus 'Man is an animal' is a categorical proposition.

(*k*) A *hypothesis* is a supposition which is made without evidence (or sufficient evidence) in order that we may compare its conclusions with actual facts, and thus at last arrive at some general, after the elimination of false, hypotheses.

The theory of gravitation was at first merely a hypothesis until substantiated by astronomical observations and calculations.

III. MENTAL ARITHMETIC TEST.

You are to enter the answer in the space ( ) left for it after each question. Nothing is to be written on this paper except the answers. No erasures or alterations are permitted ; they will be accounted errors.

1. $(75 + 130) - (29 + 16 + 82)$. ( )

2. $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{8}$. ( )

3. What is the length of the radius of a circle whose circumference measures 314,159 ft. ?

4. Multiply 2,348 by 25. ( )

5. $(26)^2 + (25)^2$. ( )

6. 351 articles at 3½d. each.

7. Express in pounds, shillings, and pence (approximately and to farthings only) the following amounts :—

£1·725 ; £·634 ; £25·472 ; £15·075. ( )

8. Express in decimals of a pound to the third place the following sums :—

£14 7s. 6d. ; 18s. 3d. ; £1 18s. 10d. ; £4 2s. 5d. ( )

9. What is the price of 3 gross at 7½d. each ? ( )

10. Put into the vacant spaces the numbers needed to complete these statements of proportion :—( ) : 15 :: 12 : 36 ; 2 : ( ) :: 20 : 380 ; 5d. : 7½d. :: ( ) : 93 ; 28 : 7 :: 624 : ( ).

11. 7 lbs. of tea at 1½d. per oz. ( )

12. How many days elapse between the 27th Sept. and the 13th Feb. ? ( )

13. A bookseller allows 25 per cent. discount. At what price will he sell 20 books published at 2s. 6d. each. ( )

14. How many coins worth 2½d. each could be had in change for £4 10s. ? ( )

ANSWERS.

(1) 78 ; (2) $\frac{15}{16}$; (3) 50,000 ft. ; (4) 58,700 ; (5) 51 ; (6) £5 2s. 4½d. ; (7) £1 14s. 6d., 12s. 8d., £25 9s. 5½d., £15 1s. 6d. ; (8) £14·375, £·913, £1·942, £4·121 ; (9) £13 10s. 0d. ; (10) 5, 38, 60, 156 ; (11) 14s. 0d. ; (12) 138 ; (13) £1 17s. 6d. ; (14) 480.

IV. Bacon's Antitheta, etc.

Essay XXVII.

For.	*Against.*
1. Friendship does for us the work of fortitude, only more pleasantly.	1. He that links himself in close friendship fetters himself with new necessities.
2. Friendship gives a sweeter flavour to every blessing.	2. It is the mark of a weak mind to wish to go shares in fortune.
3. It is the worst kind of solitude to have no true friends.	
4. It is a punishment of bad faith to be deprived of friends.	

Essay XXX.

1. Anxiety about health keeps the mind too low as if it were a suitor to the body.	1. Every recovery from illness is a fresh youth.
2. A healthy body is the soul's host; a sick body is the soul's jailor.	2. Ill-health is a very serviceable excuse, which we are glad to use even when well.
3. Good health is the best forwarder of actions; but weak health keeps holiday too much.	3. Health unites body and soul somewhat too closely.
	4. The couch and litter have ere now swayed great empires and great armies.

Essay XXXI.

1. Distrust makes the sinews of Prudence; but suspicion is a medicine for the joints.	1. Suspicion gives honour its discharge.
2. The man whose faith can be shaken by suspicion may be deservedly suspected.	2. Immoderate suspicion is a kind of civil madness.
3. Suspicion loosens weak faith, but strengthens strong faith.	

Essay XXXVIII.

1. In custom we have Arithmetical, in nature Geometrical Progression.	1. We think according to nature, we speak according to instruction; but we act according to custom.
2. As common laws are to customs in state, so nature is to custom in individuals.	2. Nature is a bookish schoolmaster; custom a magistrate.
3. Custom, when opposed to nature, is a kind of despotism: soon and lightly overthrown.	

Specimen of Bacon's Spelling.

Dictation.

To the most high and excellent Prince Henry, Prince of Wales, D: of Cornwall and Earle of Chester.

Yt may please your H.

Having devided my life into the contemplative and active parte, I am desirous to give his M, and yo^{r} H. of the fruite of both, simple thoughe they be. To write iust Treatises requireth leasure in the Writer, and leasure in the Reader, and therefore are not so fitt, neither in regard of yo^{r} H: princely affaires, nor in regard of my continuall service, w^{ch} is the cause, that hath made me choose to write certaine breif notes, sett downe rather significantlye, then curiosly, w^{ch} I have called ESSAIES. The word is late, but the thing is auncient. For Senecaes Epistles to Lucilius, yf one marke them well, are but Essaies.—That is dispersed Meditacons, thoughe conveyed in the forme of Epistles. Theis labors of myne I know cannot be worthie of yo^{r} H: for what can be worthie of you. But my hope is, they may be as graynes of salte, that will rather give you an appetite, then offend you wth satiety. And althoughe they handle those things wherein both mens Lives and theire pens are most conversant yet (What I have attained, I knowe not) but I have endeavoured to make them not vulgar; but of a nature, whereof a man shall find much in experience, litle in bookes; so as they are neither repeticons nor fancies. But howsoever, I shall most humbly desier yo^{r} H: to accept them in gratious part, and so contrive that if I cannot rest, but must shewe my dutifull, and devoted affection to yo^{r} H: in theis things w^{ch} proceed from myself, I shalbe much more ready to doe it, in performance of yo^{r} princely commaundmente; And so wishing yo^{r} H: all princely felicitye I rest.

Yo^{r} H: most humble Servant.

V. Typical Mathematical Problems.

(*a*) A and B take shares in a concern to the amount altogether of £500; they sell out at par, A at the end of 2 years, B at the end of 1 year, and each receives in capital and profit £297. How much did each embark?

Let x = amount investment by A in pounds, and let y = rate of profit per cent. per annum in pounds.

Then (i) $x + \frac{2xy}{100} = 297$

(ii) $(500 - x) + \frac{8y(500 - x)}{100} = 297$

(i) $x + \frac{xy}{50} = 297$

(ii) $-x + 40y - \frac{4xy}{50} = -203$

(i) $4xy + \frac{4xy}{50} = 1188$

(ii) $-x + 40y - \frac{4xy}{50} = -203$

Adding: $3x + 40y = 985$; $\therefore 40y = 985 - 3x$;

$$\therefore y = \frac{985 - 3x}{40}.$$

(i) $x + \frac{xy}{50} = 297$; $\therefore x + \left(\frac{985 - 3x}{40} \times \frac{x}{50}\right) = 297$;

$\therefore 2000x + 985x - 3x^2 = 594000.$

$-3x^2 + 2985x = 594000.$

$x^2 - 995x = -198000.$

$$x^2 - 995x + \left(\frac{995}{2}\right)^2 = \frac{990025}{4} - 198000$$

$$= \frac{990025 - 792000}{4}$$

$$= \frac{198025}{4}.$$

$$x - \frac{995}{2} = \pm\frac{445}{2}.$$

$$x = \pm\frac{445}{2} + \frac{995}{2}; \quad \therefore x = 720, \text{ or } 275;$$

$\therefore$ Amount invested by A = £275
Amount invested by B = £225

(*b*) I have a hollow cube, one side of which measures $4\frac{1}{3}$ inches; the wood is $\frac{1}{3}$ inch thick. Find the difference between the cubic measurement of the wood, and the measurement of 6 pieces of wood 4 inches square by $\frac{1}{3}$ inch.

Quantity of wood in box

$$= \{[(4\tfrac{1}{3} \times 4\tfrac{1}{3}) + \{4\tfrac{1}{3} \times (4\tfrac{1}{3} - \tfrac{1}{3})\} + \{(4\tfrac{1}{3} - \tfrac{1}{3}) \times (4\tfrac{1}{3} - \tfrac{1}{3})\}] \times 2 \times \tfrac{1}{3}\} \text{ cub. in.}$$

$$= \{[(\tfrac{13}{3} \times \tfrac{13}{3}) + (\tfrac{13}{3} \times \tfrac{11}{3}) + (\tfrac{11}{3} \times \tfrac{11}{3})] \times \tfrac{2}{3}\} \text{ cub. in.}$$

$$= \left\{\left(\frac{169}{9} + \frac{143}{9} + \frac{121}{9}\right) \times \frac{2}{3}\right\} \text{ cub. in.}$$

$$= \left(\frac{433}{9} \times \frac{2}{3}\right) \text{ cub. in.} = \frac{866}{27} \text{ cub. in.} = 32\tfrac{2}{27} \text{ cub. in.}$$

Quantity of wood in the pieces $= \left(4 \times 4 \times \frac{1}{3} \times 6\right)$ cub. in.

$= 32$ cub. in.

$\therefore$ Difference $= (32\frac{2}{27} - 32)$ cub. in. $= \underline{\frac{2}{27} \text{ cub. in.}}$ Ans.

(*c*) Find the present value of an annuity of £247, payable by *monthly* instalments of £20 11s. 8d. each, for $14\frac{1}{4}$ years, *i.e.*, 171 months, reckoning compound interest at 5 per cent. per annum.

Let P denote the present value in pounds, A a monthly instalment in pounds, R the amount of one pound in one month, and n the number of months.

Then $$PR^n = \frac{R^n - 1}{R - 1} \cdot A;$$

that is, $$P \times (\tfrac{241}{240})^{171} = \frac{(\tfrac{241}{240})^{171} - 1}{\tfrac{241}{240} - 1} \times \frac{247}{12}.$$

$$\left.\begin{aligned}\text{Log. } (\tfrac{241}{240})^{171} &= (\log. 241 - \log. 240) \times 171\\ &= (2{\cdot}3820170 - 2{\cdot}3802112) \times 171\\ &= {\cdot}0018058 \times 171 = {\cdot}3087918\\ &= \log. 2{\cdot}0360656\ ;\end{aligned}\right\}$$

$$\therefore P \times 2{\cdot}0360656 = \frac{1{\cdot}0360656}{2\frac{1}{240}} \times \frac{247}{12}$$

$$= 1{\cdot}0360656 \times \frac{247}{12} \times \frac{240}{241}\ ;$$

$$\therefore P = \frac{2590164}{1036065\cancel{6} \times 247 \times 20}\ £$$

$$\begin{array}{r}2036065\cancel{6}\\ 5590164\\ 1272541\end{array}$$

$$= 2590164$$
$$247$$
$$\overline{18131148}$$
$$10360656$$
$$5180328$$
$$\overline{639770508}$$
$$5$$
$$\overline{1272541)3198852540(2513£}$$
$$2545082$$
$$\overline{6537705}$$
$$6362705$$
$$\overline{1750004}$$
$$1272541$$
$$\overline{4774630}$$
$$3817623$$
$$\overline{957007}$$
$$20$$
$$\overline{19140140(15s.}$$
$$1272541$$
$$\overline{6414730}$$
$$6362705$$
$$\overline{52025}$$

$$= £2513\ 15s.\quad \text{Ans.}$$

Note.—The process by ordinary Arithmetic would be very tedious, as $2\frac{1}{240}$ has to be raised to the 171st power.

(*d*). Find the present value of an annuity of £247, payable annually for $14\frac{1}{2}$ years, reckoning compound interest at 5 per cent.

Let P denote the present value in pounds, A the annuity in pounds, R the amount of £1 in 1 year, and n the number of years.

Then $$PR^n = \frac{R^n - 1}{R - 1}\,A.$$

$$P \times (\tfrac{21}{20})^{14\frac{1}{2}} = \frac{(\frac{21}{20})^{14\frac{1}{2}} - 1}{\frac{21}{20} - 1} \times 247.$$

$$\left.\begin{aligned}\text{Log. } (\tfrac{21}{20})^{14\frac{1}{2}} &= \log. 1{\cdot}05 \times 14\tfrac{1}{2} = {\cdot}0211892991\\ &\qquad\qquad\qquad\qquad\qquad\qquad 14\tfrac{1}{2}\\ &\qquad\qquad\qquad\qquad\qquad\overline{847571964}\\ &\qquad\qquad\qquad\qquad\quad 211892991\\ &\qquad\qquad\qquad\qquad\quad\ 5297324775\\ &\qquad\qquad\qquad\qquad\overline{{\cdot}301947512175}\\ &= \log. 2{\cdot}004 \times 2205\ ;\end{aligned}\right\}$$

$$\therefore P \times 2{\cdot}0042205 = \frac{1{\cdot}0042205}{\frac{1}{20}} \times 247$$

$$= 20{\cdot}08441 \times 247$$
$$\overline{\ \ 247}$$
$$\overline{14059087}$$
$$8033764$$
$$4016882$$
$$\overline{4960{\cdot}84927}$$

$$P = \frac{4960{\cdot}84927}{2{\cdot}0042205}\,£ = \frac{496084927\cancel{00}}{20042205}\,£ = \frac{9921698540}{4008441}\,£$$

$$= 4008441)9921698540(2475£$$
$$8016882$$
$$\overline{19048165}$$
$$16033764$$
$$\overline{30144014}$$
$$28059087$$
$$\overline{20849270}$$
$$20042205$$
$$\overline{807065}$$
$$20$$
$$\overline{16141300(4s.}$$
$$16033764$$
$$\overline{107536}$$

$$= £2475\ 4s.\quad \text{Ans.}$$

(*e*) Given $\frac{a^2x}{1 - a\sqrt{x}} = \frac{a}{\sqrt{x}} + \frac{1}{1 - a\sqrt{x}}$, to find value of x.

$$\frac{a^2x}{1 - a\sqrt{x}} = \frac{a}{\sqrt{x}} + \frac{1}{1 - a\sqrt{x}}\ ;\ -\frac{a}{\sqrt{x}} = \frac{1 - a^2x}{1 - a\sqrt{x}}$$

$$= \frac{(1 + a\sqrt{x})\,(1 - a\sqrt{x})}{1 - a\sqrt{x}} = 1 + a\sqrt{x}\ ;$$

$$\therefore -a = \sqrt{x} + ax.$$

$$ax + \sqrt{x} = -a.$$

$$x + \frac{\sqrt{x}}{a} = -1.$$

$$x + \frac{\sqrt{x}}{a} + \left(\frac{1}{2a}\right)^2 = \frac{1}{4a^2} - 1 = \frac{1 - 4a^2}{4a^2}.$$

$$\sqrt{x} + \frac{1}{2a} = \frac{\pm\sqrt{1 - 4a^2}}{2a}.$$

$$\sqrt{x} = \frac{\pm\sqrt{1 - 4a^2} - 1}{2a}\ ;$$

$$\therefore x = \left\{\frac{\pm\sqrt{1 - 4a^2} - 1}{2a}\right\}^2.$$

Or:

$$x = \frac{1 - 4a^2 \pm 2\sqrt{1 - 4a^2} + 1}{4a^2} = \frac{2 - 4a^2 \pm 2\sqrt{1 - 4a^2}}{4a^2}$$

$$= \frac{(1 - 2a^2) \pm \sqrt{1 - 4a^2}}{2a^2}.$$

(*f*) If the m^{th} term of an A.P. be n, and the n^{th} term be m, of how many terms will the sum be $\frac{1}{2}(m + n)\,(m + n - 1)$, and what will be the last of them?

If a = 1st term, and d = difference,

Then $$\left.\begin{aligned}&(1)\ n = a + (m - 1)d\\ &(2)\ m = a + (n - 1)d\end{aligned}\right\}$$

Subtracting: $$n - m = (m - n)d\ ;$$

$$\therefore d = \frac{n - m}{m - n} = -1.$$

(1) $$n = a + (m - 1)d = a + [(m - 1) \times -1] = a - m + 1.$$

$$\therefore a = m + n - 1.$$

Let x = No. of terms; then $\frac{x}{2}[2a + (x - 1)\,a]$ = Sum of terms.

$$\therefore \frac{x}{2}\{2(m + n - 1) + [(x - 1) \times -1]\} = \tfrac{1}{2}(m + n)\,(m + n - 1).$$

$$x(2m + 2n - 2 - x + 1) = (m + n)\,(m + n - 1)$$

$$-x^2 + x(2m + 2n - 1) = (m + n)^2 - (m + n).$$

$$x^2 - x(2m + 2n - 1) = -(m + n)^2 + (m + n).$$

Completing the square:

$$x^2 - x(2m + 2n - 1) + \left(\frac{2m + 2n - 1}{2}\right)^2$$

$$= \left(\frac{2m + 2n - 1}{2}\right)^2 - (m + n)^2 + (m + n)$$

$$= [(m + n) - \tfrac{1}{2}]^2 - (m + n)^2 + (m + n)$$

$$= (m + n)^2 - (m + n) + \tfrac{1}{4} - (m + n)^2 + (m + n)$$

$$= \tfrac{1}{4}.$$

Extracting square root :

$$x - \frac{2m+2n-1}{2} = \pm\tfrac{1}{2};$$

$$\therefore x = m+n-\tfrac{1}{2}\pm\tfrac{1}{2}$$
$$= (m+n-1), \text{ or } (m+n).$$

In the former case, the last term

$$= (m+n-1)+[\{(m+n-1)-1\}\times -1]$$
$$= m+n-1-m-n+2 = 1.$$

In the latter case the last term

$$= (m+n-1)+\{[(m+n)-1]\times -1\}$$
$$= m+n-1-m-n+1 = \underline{0}.$$

VI. HINTS ON EUCLID.

Only seven questions are allowed to be answered, and at least ten will be given from which the selection may be made. The first nine will probably be duplex, consisting both of a proposition and a deduction, whilst the tenth may be a deduction alone, but presenting more than the average difficulty. In answering, 'Capital letters' (excluding A, B, C, D, E, F), not numbers, must be used in the diagrams. The only signs allowed are + and =. The square on PQ may be written 'sq. on PQ,' and the rectangle contained by PQ and RS, 'rect. PQ, RS.' Other abbreviations, if employed, must not be ambiguous.

First will doubtless come (as is the invariable practice) two questions on Book I., followed by one question on Book II., two on Book III., two on Book IV., two on Book VI., and lastly the aforesaid difficult deduction.

The examiners appear, especially during the last six years, to have no favourite questions on Book I., but throughout the remaining books the inquisitorial mind is fairly manifest. In Book II., Propositions 3, 4, 12, 14; in Book III., Propositions 3 (set four times), 15, 17, 18 (set three times), 22 (four times), 32, 35, 36; in Book IV., 4, 5, 6, 10 (four times); in Book VI., 2 (four times), 8, 13, are evidently in the highest esteem.

The propositions should be frequently revised by the pupil. This, even with our limited time, is quite practicable, as from forty to sixty minutes is quite sufficient to reperuse even Book I. or III. The practice of merely committing to memory is as useless as it is foolish.

Not only should Euclid's results be thoroughly understood, but an intelligent idea of the logical methods employed (such as 'Superposition,' 'Reductio ad absurdum,' 'Reductio ad *exhaustum*') should be conceived. All the divers converses of theorems, all the terms employed, all the restrictions introduced, should be capable of enunciation and explanation by the student.

The deductions (and we use the term generally to comprise 'Riders,' 'Exercises,' 'Cuts,' etc.) are generally based upon the annexed propositions. Those upon Book III. and those from Book I., applied to exercises upon other 'Books,' are most in vogue. 'Candidates are reminded that correct solutions of the deductions obtain high marks.'

They are thus of higher value than the propositions, and rightly so, for they are practically innumerable and cannot be mechanically crammed up like the limited number of the propositions.

Even books of deductions should only be used like Arithmetical 'Keys.' They are exceedingly useful as walking-sticks, but utterly useless as crutches.

The examinee must become skilled in Geometrical Analysis (speciments of which are given in every good edition of Euclid) and especially should he be able to construct triangles, as these are really the foundation of all constructions.

If when our students are endeavouring to solve deductions, they are able to propound original ones which their investigations have suggested, the unction of confidence may be fairly applied, but the mind which cannot originate deductions cannot retain communicated ones.

The following 'Key' Deductions are of essential importance, and are useful (speaking generally) throughout all the 'six books':—

'The line joining the middle points of the sides of a triangle is parallel to the base.'

'The middle point of the hypotenuse of a right-angled triangle is equidistant from the three angles.'

'The perpendicular from a given point upon a given straight line is the shortest line that can be drawn from the point to the line.'

'The diagonals of parallelograms bisect one another.'

'Equal triangles upon equal bases are between equidistant parallels.'

'The sum of the squares on the sides of any triangle is double of the sum of the squares on half the base, and the line joining the vertex to the middle point of the base.'

'The common chord of two intersecting circles bisects the common tangent.'

Considerations of symmetry frequently assist the solver, *e.g.*, 'in inscribing an equilateral triangle in a square.' Here it is evident that the sides of the triangle must meet in the extremity of, and be equally inclined to the diagonal of, the square.

By considering extreme 'cases' we can often arrive at a general solution, as in, 'if from any point without a circle, lines be drawn cutting the circle, and making equal angles with the longest line, they will cut off equal segments.'

By imagining the extreme case, where the given point is in the circumference, the demonstration is at once suggested.

A general solution can often be built up from the simple cases: see Euclid III., 35.

As Book III. is so much utilised, it would be well for the student to take the elements of ordinary problems (such as points, lines, angles, circles, touching, cutting, intercepting) and combine them (generally in threes) into every possible variety.

A very difficult and instructive exercise is to prove that certain problems are impossible. Maxima, Minima, Constants, and Loci should not be neglected. Proposition III., 15 is an example of Maxima, and Propositions III., 7, 8, of both Maxima and Minima. As an instance of 'Constants,' 'The sum of the opposite angles of any quadrilateral figure described in a circle is invariable,' may be adduced. As a specimen of 'Loci' take the following: 'The loci of the vertices of all equal triangles upon the same base are lines parallel to this base.'

VII.—The official Time Table of the Certificate Examination, giving the particulars respecting the papers in each subject, has not been received up to the time of going to press.

CORRESPONDENCE.

We shall be pleased to reply briefly through these columns to any SUBSCRIBER *seeking examinational information or advice, and* **Enclosing the Necessary Coupon.**

This privilege does not, of course, extend to furnishing the solutions and answers of problems. All such communications should be addressed to 'THE QUERY EDITOR.'

Replies demanding urgency will be promptly forwarded per post on the receipt of a stamped and addressed envelope, **Accompanied by the Requisite Coupon.**

A post will be saved by writing direct to GEORGE BEACH, STANLEY MOUNT, MACCLESFIELD.

J.F. (Limehouse).—No stamp was enclosed. The standard is the same for external candidates. The works you mention are ample.

S.A. (——).—You will receive the special 'D' in due course. We receive many complaints of undue delay in its issue.

N.R. (Appleby); H.C. (Badminton); F.U. (Peel); A.F. (Warrington); 'W.' (——).—Published by Macmillan & Co.

A.L. (Chatham).—The Department will forward a gratis copy of syllabus, but not of questions.

W.O.K. (Stowmarket).—Sum of $x+a$, x^2+2a, x^3+3a etc., is a problem partly G.P. and partly A.P. Sum the parts up separately.

D.P. (Pontardulais).—We are sorry that our space does not permit us complying with your request. A perusal of the daily papers would answer your purpose.

K.C. (Thurso) wishes to know of a key to '*Le Petit Chose.*' Can any reader oblige?

A.J.F. (Carmarthen).—You must take the Arithmetics.

ANSWERED PER ORDINARY LETTER.—'DOUBTFUL' (St. Mark's); J.H. (Holbrooke); A.P. (Atherstone); D.W. (Rochdale); F.D. (Warrington); M.F. (Birkenhead); S.B. (Oldbury); J.C.G. (Wednesbury); W.W. (Bransty); T.F. (Stafford); R.J.

(Coleshill); F.W. (Braintree); 'NUX' (Burton); J.L. (Chorley); N.S. (Devizes); A.H. (Aigburth); B.L. (Louth); S.S. (Westbourne); H.W.B. (Alnwick); A.J.R. (Stocksfield); J.B.C. (Crewe); A.J.H. (Ashley); E.O.S. (Yaxley); N.V. (Ampthill); 'OC' (Faringdon); L.S. (Easton); J.P. (Cleveland); 'SUN' (Honiton); K.H. (Knaresborough); E.T. (Gosport); H.W. (Retford); J.P. (Market Drayton); E.W. (Macclesfield); E.P. (Kidderminster); E.S. (Todmorden); A.C. (Hulme); A.C.S. (Millport); E.M.L. (Gosport); E.M.D. (Wolverley); A.F. (Congleton); E.D. (Newcastle); A.W.D. (Newcastle); H.A.C. (Mile End); M.O.M. (Regent Square); M.C. (Croston); G.F.R. (Northampton); C.A.B. (Rock Ferry); M.T. (Harpurhey); 'LUNAR' (Bideford); A.B. (Cannock); M.T. (Penrith); K.I. (Ninebanks); M.W. (Walton); S.H. (Ware); 'BRUN' (Hereford); S.A. (Mansfield).

LONDON MATRICULATION.

PREPARATION CLASS FOR JANUARY, 1895.

BY R. C. B. KERIN, B.A. (LOND.),
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LATIN.

Latin Course for December.

1. Vergil, Aeneid V., line 800 to end. Revise lines 452–800.

2. Grammar: Postgate's Latin Primer (Cassell), §§ 421–430; §§ 457–459; or Allen's Latin Grammar (Clarendon Press) §§ 170–176; §§ 200–203; § 299; §§ 304–312; §§ 364–391.
Revise the grammar course up to October work.

3. Translation at sight: a couple of pieces a week.

4. Bayfield: Exercises 24–80, the 15th in each.

Notes on Vergil, V., 605 to the end.

608. *dolorem*, acc. after the pass. participle *saturata*, used in the sense of the Greek middle.

609. Note the separation of *per* from the word it governs (*arcum*).

610. *nulli*, dat. of agent used after *visa*, 'seen by none.' The gen. and abl. of *nemo* are wanting; their place is supplied by *nullius* and *nullo;* for the dative *nemini* and *nulli* are found.

613. Note the word *acta*.

616. Note the infinitive of exclamation *superesse*.

617. For construction of *taedet*, see grammar under accusative case.

620. *fit*, 'becomes.'

622. *mediam se matribus infert*, 'goes into the midst of the matrons.' Note that the Vergilian idiom here is different from ours, *mediam* agreeing with *se*.

623. *traxerit*—the relative is causal (since . . .), hence subjunctive.

629. *undis*, 'by the waves,' abl. of instrument.

631. Distinguish *iacĕre* from *iacio* (as here), and *iacēre* from *iaceo*.

635. *quin*, 'nay'; in this sense *quin* is of course not followed by the subjunctive.

641. *prima corripit*, 'she is the first to seize.'

642. *sublata dextra*, 'raising up her right hand,' ablative absolute. *Connixa* agrees with subject of *coruscat*, 'with mighty effort she brandishes.'

643. *arrectae* = *arrectae sunt*.

644. *Iliadum*, feminine patronymic.

647. The scansion shows that the last word is *decŏris*, not *decōris*, hence the nom. is *decor*, a masculine word of the third declension, and not *decus* (the gen. of which is *decŏris*), a neuter word of the third.

649. *sit* is understood.

650. *egomet*. *Met* is a strengthening suffix.

651. *careret, quod* in the meaning 'because' is followed by the subjunctive when it introduces the reason of someone other than the speaker or writer. Here it introduces the reported reason of Beroe. This is called the subjunctive of sub-oblique oration.

652. *meritos*, 'due.'

654. *primo*, 'at first'; *primum*, 'first.'

655. *ambiguae inter*, 'wavering between.'

656. *amorem terrae*, 'love for the land,' *terrae* objective genitive.

661. *Pars*, singular in form but plural in meaning ('some,') hence plural verb *spoliant*.

663. *per* governs *transtra: abiete*, abl. of material.

664. *cuneos*, 'wedges,' here 'seats.' Seats in the Roman amphitheatre were wedge-shaped.

665. *incensas esse*, inf. after *perfert*.

668. *equo*, 'with his horse,' to be taken either with *acer* or *petīvit*, 'quickly sought on horseback.'

676. *diversa per litora*, 'on different parts of the shore.'

678. *piget* takes an acc. of the person and gen. of the thing, like *taedet* above.

683. Remember *est* is here the 3rd sing. of *edo*, to 'consume,' and is not from *sum*. It governs *carinas*.

685. The infinitives in this and the next line are *historical* infinitives. The subject of such infinitives is always in the nominative, hence *Aeneas*.

687. *exosus* = *exosus es*.

689. *da classi*, 'permit the fleet.'

695. *ardua*, neut. plural of the adjective *arduus* used as a noun, 'heights.'

697. Some consider *implentur super puppes* to mean 'filled to overflowing,' and not 'are filled from above.'
Semiusta, scanned *sēmiustă;* the scanning of two syllables as one is called *synizesis*.

702. *resideret*, subjunctive in a dependent question.

703. *oblītus* (as here), from *obliviscor*, governs the genitive *fatorum; oblītus* comes from *oblino*.

706. *portenderet* and *posceret* are in the subjunctive, because the *relative quae* is used consecutively, and is equivalent to 'such as.' *Vel . . . vel* is used for '*either . . . or*' when there is no contrast between the alternatives.

713. *amissis superant qui navibus*, literally 'those who are left over, the ships having been lost,' *i.e.*, 'those who are left over now that the ships are lost.'

714. *Pertaesum* used impersonally governs acc. of person (*quos*) and gen. of thing (*incepti, rerum*).

717. Remember *sine* is here the pres. imperative of *sino* 'allow,' and is followed by the subjunctive *habeant* = 'let them have.' *His terris*, local ablative, 'on these lands.'

722. *caelo delapsa*, 'gliding down from heaven.'

724. *vita*, abl. of comparison, to be taken with *care magis* in the next line, 'dearer than life.'

727. *miseratus* = *miseratus est*.

728. The three verbs *pario, pareo* (here), and *paro*, should be carefully distinguished.

730. *defer*. Remember the four imperatives that drop *e* in the 2nd singular of the present imperative, viz., *dico, duco, fero* and *facio*.

730. *cultu*, abl. of respect; *aspera cultu* lit. means 'rough in point of cultivation,' hence 'uncivilised.'

731. *Latio*, 'in Latium,' local ablative without the preposition 'in.'

733. *congressus meos*, 'a meeting with me,' poetical plural.

736. Distinguish *pecus, pecoris* (neuter), and *pecus, pecudis* (fem.).

737. *dentur*, subjunctive in a dependent question.

745. Note meaning of *acerra*.

750. *transcribunt urbi*, 'enrol in the town.'

751. *Egentes* governs either the genitive (as here) or the ablative.

754. *exigui numero*, 'few in number'; *numero* is ablative of respect.

760. *Veneri Idaliae*, 'in honour of Idalian Venus,' dat. of advantage.

761. A spondaic line, that is a line the last foot but one of which is a spondee.

766. *complexi inter se*, 'embracing each other.' Note how to express 'each other' in Latin.

774. *caput*, acc. after *evinctus*, 'having his head bound. Cp. *dolorem* above, 608.

783. *longa dies*, 'long length of time'; *dies* is fem. in this sense.

786. *odiis*, either to be later dative with *satis*, 'enough for her hatred,' or ablative with *exedisse*, 'to have eaten out with her hatred.' Note the contracted form *traxe*.

788. *insequitur*, 'pursues.'

'Let her be well assured that she has reasons, for I know of none' (Conington).

790. *excierit*, subjunctive in a dependent question.

797. *tibi* is best taken, as Conington holds, with *dare vela*.

811. The allusion should be known.

813. *tutus*, 'in safety.'

816. *laeta deae permulsit pectora*, 'soothed to joy the bosom of the goddess' (Mackail): *laeta* is used proleptically, lit. 'soothed so as to be joyful.'

821. *aquis*, 'in its waters,' ablative of respect.

822. *Cete*, a Greek plural.

823. *Inous*, gen. of Ino, which, like *echo*, etc., is only used in the singular and is the same throughout, except in the genitive.

825. *laeva*, 'the left,' acc. neut. plural of the adjective used as a noun.

829–832. The nautical terms should be mastered.

831. *solvēre*, 3rd plural, perf. indic., act., to be distinguished from *solvĕre*, pres. inf. of *solvo*.

832. *sua*, lit. 'its own breezes bear the fleet,' *i.e.*, the breezes which suit it bear it, hence *sua* here means 'favouring.'

838. *lĕvis*, 'light,' 'lightly.'

839. *Aera*, Greek accusative.

842. *similis*, 'like,' is followed either by the genitive or the dative.

856. *cunctanti*, dat. of interest.

860. *proiecit praecipitem*, 'threw him headlong.'

861. Note declension of *ales*.

862. *non setius*, 'just the same,' lit. 'not otherwise.'

Latin Grammar Notes.

October and November Course.

Students should remember that in conditional statements the following are the normal rules:—

(1) The Indicative or Imperative is found in the Apodosis (principal clause), Indicative in Protasis ('if' clause).

(2) Subjunctive in Apodosis, Subjunctive also in Protasis. The Subjunctive is used in Apodosis if there is a 'would' or 'would have' in English, or the equivalent of 'would' or 'would have.'

The best practical rule for the student to go by is this. Let him look to the *apodosis* and see will the subjunctive be required as above, if not let him use the indicative in both.

Now the next question is that of the tense to be used. If the subjunctive is required, use the present subjunctive to denote future time, the imperfect subjunctive to denote present time, and the imperfect or pluperfect subjunctive to denote past time. If the indicative is used, the tenses will be the same as in English, except in regard to future time, where in English in the Protasis the present is used to denote future time. In that case the future must be used in Latin in both clauses if both actions go on together in the future, if one is over before the other begins, the future perfect and future are to be used, *e.g.*, *hoc faciam si potero*, 'I shall do this,' if I can. *Si vitiis indulseris, paenas dabis*, 'if you indulge your faults you will suffer.' In the first case the actions denoted by '*faciam*' and *potero* go on together; in the second case the indulgence is over before the suffering begins.

The methods of expressing purpose and result are important. Avoid using the infinitive to express a purpose. There is no mistake which is so often made, or which has so often weighed down the wrong scale when the examinee's fate is in the balance. Remember that 'that not' is translated by *ut non* in a negative result, by *ne* in a negative purpose. In the same way *ut nemo* is 'so that no one,' *ne quis* 'in order that no one.'

Verbs of fearing are followed by (*a*) *ne* and subjunctive to represent a 'that clause' in English; (*b*) *ut* (or *ne non*) to represent a '*that not* clause' in English, (*c*) infinitive when there is an infinitive in English.

The subjunctive is used in Relative Clauses when the relative denotes (*a*) Purpose, (*b*) Result, (*c*) Concession, (*d*) Cause. Under heading (*b*) comes the case when the antecedent of the relative is an indefinite word, or when the relative refers to a class and not to definite persons or things. Distinguish *is est qui hoc facit* 'he is the very man who does this,' from *is est qui hoc faciat*, 'he is just the man to do this.'

Quod, meaning because, takes the subjunctive when the reason alleged is not the reason of the speaker or writer, but that of some one else. Read the examples in the grammar.

Latin Test Paper.

(1) Give the Latin for—521 soldiers, one thousand men, 3,000 horse-soldiers, ten times six are sixty, $\frac{1}{2}$, $\frac{3}{4}$, 2,000 sesterces.

(2) Give the gender, genitive and dative singular and plural (when found) of *capis, aries, ŏs, ilex, ligo, echo, Aeneas, spes, laurus*.

(3) Decline throughout—*anceps proelium, ingens senex, decor, decus, pălus, pālus*.

(4) Give the perfect indicative active 3rd plural, the supine in *-um*, and the imperfect subjunctive 1st singular of—*adeo, iacio, aufero, gaudeo, pareo, tollo, mico, lavo, torreo*.

(5) What are the various constructions of verbs of fearing in Latin? Give examples.

(6) Distinguish *ut nemo* and *ne quis; sive . . . sive* and *utrum . . . an; aliquem consulo* and *alicui consulo; castrum* and *castra*.

(7) When is the subjunctive used in a relative clause?

(8) What are the constructions of the following verbs:—*pertaedet, opus est, gloriari, minari, accuso, peto, aemulor, praestare, obliviscor, noceo, laedo?*

(9) How are adverbs formed in Latin?

Sentences.

(Solutions will be given next month.)

(1) It is ninety years since he was king. He had reigned thirty years.

(2) He was so saddened by the death of his father that he could never go to Rome without shedding tears.

(3) If I had asked you to do this, I should not have been prevented from going away.

(4) Who could have doubted that it was all over with the army?

(5) There are some who are afraid to die for their native land; many would rather die thus than live without honour.

(6) The first thing to be demanded of an orator is that he should speak well.

(7) Phocian supported his friend, though he might have abandoned him with impunity.

(8) He stopped in the city of Rome till the Senate broke up.

(9) Hearing that Pompeius was ten miles away from Rome, he wheeled round his forces and charged the enemy, who were off their guard.

English Course for December.

(1) Hewitt & Beach, pp. 387–431, 595–633, 677–695; or Morris's 'Outlines of English Accidence,' ch. xviii. Analysis in Beach's Outlines.

(2) History from the Execution of Charles I. to 1700. Revise from Henry VI. to James I.

English Notes.

Our English alphabet is both defective and redundant; defective because it has not enough letters to represent each sound, redundant because certain of its letters are unnecessary, *e.g.*, G, X, and C. Again, our alphabet is imperfect because the essential characteristics of a perfect alphabet are two in number: each letter should represent one sound and one sound only; each sound should be represented by one letter only. A reference to the examples given in the grammar will show that English cannot claim perfection in its alphabet.

Our English spelling, which is so often a trap to the unwary foreigner, and, sad as the confession is, to many a native, is sometimes called 'etymological,' because it assumes to the eye the form of original Latin or Greek words. The Anglo-Saxon alphabet was borrowed from the Celts, who borrowed it from the Romans. In the Anglo-Saxon times the spelling was, as a rule, phonetic. In the twelfth and thirteenth centuries, owing to the increase in the number of words introduced from the Anglo-French, the Anglo-Saxon symbols were gradually replaced by French ones. The Anglo-French scribes employed a continental form of the Roman Alphabet. In the fourteenth century the spelling became less phonetic. The introduction of printing in the fifteenth century stereotyped the spelling, while the pronunciation was gradually changed. In the sixteenth century arose the 'etymological' spelling, the tendency of which was to modify the spelling of English words so as to show their origin to the eye, *e.g.*, *debt*, which comes from French *dette*, had the *b* inserted to show its ultimate derivation from Latin *debitum*. Since 1690 A.D., the spelling has changed very little, but the pronunciation has changed greatly, especially at the time of the civil war. Hence our spelling at the present day represents, roughly speaking, the pronunciation in vogue in the time of Elizabeth. For a fuller account see Skeat's 'Primer,' chapter iii.

Grimm's law is very important; it explains certain sound shiftings observable in the Indo-European languages. The old form of Grimm's law found in Hewitt & Beach, &c., is now found to be inaccurate. Skeat, in his etymology, gives the modified form which is now generally adopted.

'Writing down the following rows of letters:—

DH, D, T, TH,
BH, B, P, PH (F),
GH, G, K, KH (H),
GHw, Gw, Q, KHw (Hw), ,,

the law is: In each case the Indo-Germanic sound corresponding to any symbol (except the last) in any row, is shifted in cognate Germanic words to the sound corresponding to the symbol which next succeeds it.' Grimm attempted in the old form of the law to include a second set of sound shiftings which took place between the high German and low German languages. Examples of the above law are found in Skeat's 'Primer.'

Verner's law accounts for certain apparent exceptions to Grimm's law. Skeat states it thus: 'If an Indo-Germanic K, T, or P immediately follows the position of the accent, it shifts regularly to the low German H, TH, or F, otherwise it becomes (as by a further shifting) GH (g), DH (d), BH (b = v).' To illustrate, Skeat gives as examples—*pater*, *mater*, *frater*. The Anglo-Saxon forms, by Grimm's law, should be *fæper*, *mōpor*, *brōpor*, whereas they are *fæder*, *mōdor*, *brōpor*. 'In Sanscrit, the true old nominatives of 'father,' 'mother,' and 'brother,' respectively *pitá·r*, *matá·r*, *bhrā·tar*, where the dot shows the position of the accent. In *bhrā·tar* the accent preceded the *t*, and the shiftings were regular; cf. E. *brother*, G. *Bruder*. But in *pitá·r*, *matá·r*, the accent did not precede the *t*, hence a further shifting took place, giving A.S. *fæder* and *modor*.'

It should be noted that in applying Grimm's law we must get the earliest form of English words.

French Course for December.

(1) Six pages of translation a week, with a certain amount of written translation.

(2) Grammar — Fasnacht, §§ 124, 125; §§ 145–151; §§ 165–175. Revise the irregular verbs of second and third conjugations.

Notes.

In the paper given last month the following points are worth noting:—'A windmill' is *un moulin à vent;* 'a milk-jug,' is *un pot au lait; un pot de lait*, a jug with milk in it; *à* between two nouns denotes a purpose 'for' the noun after, *de* denotes the contents. In 'she has hurt her hands,' the pronoun *her* will not be expressed, and we shall write *elle s'est blessé les mains*, the direct object of *est blessé* being *mains*, which follows, ∴ there is no agreement. 'This day fortnight,' *d'aujourd'hui en quinze.* Note a week is *huit jours.* 'Fifteen days ago,' *il y a quinze jours.* 'What is the matter with you?' *Qu'avez-vous?* In question 3, note *lent* is an exception, and has as adverb *lentement.* In question 4, *avant* refers to time or order, *devant* to place; *auparavant* is the adverb. *Ailleurs*, 'elsewhere'; *d'ailleurs*, 'besides.' *De bonne heure*, 'early'; *à la bonne heure*, 'well and good.'

In question 5 (*a*), *présumé* will not change, as *que* is object to *recevras*, *arrivée* will become *arrivées* to agree with *lettres*, as neuter verbs conjugated with *être* agree with the subject. In 5 (*b*), *innocence* will not change, though *son* will become *leur. Convainere* was a misprint for *convaincre.* In 5 (*c*), *acheté* will not change. In 5 (*d*), *celui* will become *ceux.* In 7 (*a*), *du* should be *de* on account of the negative. In 7 (*b*), *supérieur* and not *supérieure*, as *personne*, in the sense of 'nobody,' is masculine. In 7 (*c*), we should have *l'a vu.* In 7 (*d*), write *ne me donnez*, etc., as the pronoun precedes when the imperative is used negatively. In 7 (*e*), write *de qui parlez-vous? Dont* is *not* interrogative.

Greek Course for December.

(1) Iliad xxiv. Revise the first half of xxiv.

(2) In Grammar, make up the irregular verbs given in the alphabetical list from *ν* to *ω*. In Syntax, learn Conditional Clauses, the methods of expressing a purpose, wish, result. Learn the uses of the verbals in *τέος*.

(3) Two pieces of translation at sight a week. In the first half of the Homer pay special attention to lines 263–280, which are very difficult.

MATHEMATICS.

Arithmetic Course for December.

A general revision of the subject should be commenced in which special attention may be given to Stocks, Percentages, and Interest. We append a few examples:—

(1) At what time between 3 and 4 o'clock are the hands of a clock together ?

In 1 hour the large hand goes 60 while the little hand only goes 5 minute-spaces ;

Or the large hand gains 55 minute-spaces on the little one in 1 hour (*i.e.* in 60 minutes);

And, therefore, the large hand gains 1 minute-space in $\frac{60}{55}$ or $\frac{12}{11}$ minutes.

At 3 o'clock the little hand is 15 minute-spaces ahead of the large one.

Hence they will be together when the large one has gained 15 minute-spaces on the little one, which it does in $15 \times \frac{12}{11}$ or $16\frac{4}{11}$ minutes.

They are therefore together at $16\frac{4}{11}$ minutes past 3.

(2) The real cost of an article is 56 per cent. of the price, at which it is marked for sale ; it is sold at a trade discount of $12\frac{1}{2}$ per cent. How much does the seller gain per cent. ? (Jan. 1890.)

An article marked £100 cost £56, and one marked £100 is sold for £$87\frac{1}{2}$; that is, one costing £56 is sold for £$87\frac{1}{2}$; and, therefore, one costing £100 is sold for $\frac{87\frac{1}{2} \times 100}{56}$, or £$156\frac{1}{4}$; showing that the gain per cent. is $56\frac{1}{4}$.

(3) Having given 1 metre = 39 inches approximately reduce 3·42 yards to centimetres.

3·42 yards.
36

39 | 123·12 inches.

3·157 metres approximately.
100

315·7 centimetres.

(4) Account for the fact that if from any number, say 9123468, be subtracted another number composed of the same digits differently arranged, say 1243698, the result is divisible by 9.

We know that any number when divided by 9 has the same remainder as is given by dividing the sum of its digits by 9 ; so that if two numbers are composed of the same digits, they give the same remainders when divided by 9.

Thus the numbers may be called $9x + a$ and $9y + a$, where a is the remainder.

Hence their difference $= (9x + a) - (9y + a)$
$= 9(x - y)$,

or is divisible by 9.

In the case given—

$9123468 = (9 \times 1013718) + 6.$
$1243698 = (9 \times 138188) + 6.$

Hence their difference
$= 9(1013718 - 138188) = 9 \times 875530,$

and is divisible by 9.

Note and be able to prove (algebraically) that a number divides by 3 or 9 if the sum of its digits does, and the corresponding tests for division by 11, 2, 4, and 8, as given in any text-book.

Algebra Course for December.

The revision of the algebra should be continued with special attention to Quadratic Equations, Identities, and Progressions. Look up the proof of the rule for finding H.C.F.

Below are some examples :—

(1) Prove that the sum of an odd number of terms of an arithmetical progression may be found by multiplying the middle term by the number of terms.

Let a = first term
$2n + 1$ = number of terms
d = common difference
s = required sum

Then middle term $= (n + 1)^{st}$ term $= a + nd$, and $s = \frac{2n + 1}{2}\{2a + (2n + 1 - 1)d\}$, or $(2n + 1)(a + nd)$, from which the required result at once follows.

(2) Solve $(3x - y - 2)^2 + (7x + y - 8)^2 = 0$.

Since all squares are positive,

$\therefore (3x - y - 2)^2$ and $(7x + y - 8)^2$ are both positive ;

and since their sum is zero,

$\therefore$ each must separately be zero ;

i.e., $3x - y - 2 = 0,$
and $7x + y - 8 = 0,$
giving $x = 1$, $y = 1$.

(3) A clock loses $\frac{1}{2}$ minute an hour, and is right at 6 a.m. Monday, what is the correct time when this clock shows 5.30 p.m. the following Wednesday ?

The interval between 6 a.m. Monday and 5.30 p.m. Wednesday is $59\frac{1}{2}$ hours by this incorrect clock.

Now $59\frac{1}{2}$ minutes of this clock = 60 minutes by a correct clock.

$\therefore$ $59\frac{1}{2}$ hours of this clock = 60 hours by a correct clock.

So that true time is $\frac{1}{2}$ hour in advance of the clock, *i.e.*, is 6 o'clock.

(4) Having giving the sum of $(n + 1)$ terms of an arithmetrical progression as $\frac{(n + 1)(4 + 3n)}{2}$, find the last term, and the series.

Here sum of $(n + 1)$ terms $= \frac{(n + 1)(4 + 3n)}{2}$;

$\therefore$ sum of n terms $= \frac{n(1 + 3n)}{2}$

(this is found by writing $(n - 1)$ for n).

Now last term $= (n + 1)^{st}$ term = [sum of $(n + 1)$ terms] − [sum of n terms]

$= \frac{(n + 1)(4 + 3n)}{2} - \frac{n(1 + 3n)}{2}$

$= 3n + 2.$

Putting $n = 0$, we get first term $= 2$,
$n = 1$, we get second term $= 5$,
$n = 2$, we get third term $= 8$,

or series is 2, 5, 8, 11, etc.

Euclid Course for December.

The third and fourth books should be revised, and might be supplemented by working through some of the past papers to insure being able to finish a paper in the allotted time.

Hints on November riders :

(1) Let AD be given difference of sides, produce it to C, and draw DB making ∠CDB = half a right angle.

With centre A and radius = given hypotenuse, describe a circle cutting DB in B. From B draw BC perpendicular to AC. Then ACB is required triangle.

(2) From A draw AE perpendicular to CD, and produce it to F, so that EF = AE. Join BF, cutting CD in P. Then AP.PB are lines as required.

(3) From equality of triangles, APE. FPE, we have AP = PF, so that sum of AP and PB = sum of PF and PB = BF.

If R be any other point in CD, sum of AR and RB = sum of RF and RB, which is clearly greater than BF, the sum of AP and PB.

Work the following questions:

(1) What propositions in Euclid correspond to the following algebraical identities or problems?

(*a*) $(a-b)^2 + a^2 = 2a(a-b) + b^2$.

(*b*) The solution of the equation $x^2 + ax - a^2 = 0$.

(2) Find a point equidistant from three given points.

(3) Show how to describe a regular decagon.

For the student who knows his Euclid well, a perusal of the additional theorems and worked-out problems given in any good text-book (*e.g.*, Hall and Stevens) will be advisable.

MECHANICS.

Course for December.

The Hydrostatics should be finished this month, and the chapter on Machines should be read, *i.e.*, the lever, balance, inclined plane, pulleys, and screw. Chapter XI. of Loney should be read. Note the following rules, and read up the proofs of them:—

(1) The whole pressure on any area immersed in a fluid = weight of a column of the fluid whose base is the area in question and height is the same as the depth of the centre of gravity of the area.

(2) A floating body displaces an amount of fluid whose weight is equal to the weight of the body.

Get up a careful description of the various hydrostatical instruments, viz., air pumps, hydrometers, and the like, also an experimental proof of Boyle's law.

Boyle's law states that so long as the temperature is unchanged, pressure varies inversely as volume or the product (pressure) (volume) keeps the same.

We append illustrative examples:—

(1) A diving bell (200 cubic feet) rests in water 150 feet deep. If the height of the mercury barometer be 29·5 inches, find how many cubic feet of air at atmospheric pressure are required to fill the bell. (S.G. of mercury = 13·6).

Height of water barometer = $29{\cdot}5 \times 13{\cdot}6$ inches
= 33·7 feet approximately.

The problem is equivalent to finding what volume the air in the bell (if full) would occupy if at atmospheric pressure (33·7 feet of water) instead of at the pressure at the depth of 150 feet (viz., 150 + 33·7, or 183·7 feet of water).

By Boyle's law—

(Pressure) (volume) keeps the same;

$\therefore 33{\cdot}7x = 183{\cdot}7 \times 200$,

giving required volume, or $x = 1090$ cubic feet.

(2) A force of 50 lbs. acts for a minute on a mass of 200 lbs., find the momentum required.

$$P = mf.$$
$$50 \times 32 = 200f,$$

giving $f = 8$ feet per sec. per sec.

and $\therefore v =$ feet
$= 8 \times 60$
$= 480$ feet per sec.

Hence momentum $= 200 \times 480$, or 96000 units of momentum.

A unit of momentum being that possessed by a mass of 1 lb. moving with a velocity of 1 ft. per sec.

(3) A body is dropped from a tower, and 2 seconds later a second body is projected after the first, and overtakes it in 10 seconds. With what velocity was it projected?

When they meet the first body has been falling 12 seconds, and therefore gone a distance

$= \frac{1}{2}gt^2 = 16 \times 144$ feet
$= 2304$ feet.

The second in the 10 seconds a distance

$= ut + \frac{1}{2}gt^2$
$= 10u + 1600$;

therefore $10u + 1600 = 2304$,

giving $u = 70{\cdot}4$ feet per second.

CHEMISTRY.

Course for December.

A thorough revision of the chemistry should be made, keeping close to the syllabus. Special attention should be paid to the preparations and properties of sulphuric, nitric, and hydrochloric acids, the oxides of nitrogen and ammonia.

Correspondence.

Teachers wishing to have their test papers corrected should send the same addressed to the 'Matriculation Editors,' care of Joseph Hughes and Co., Froebel House, St. Andrew's Hill, Doctors' Commons, London, E.C., and enclose a remittance of 6d. for each paper.

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[Mr. Cartwright's Article on the Rev. Canon Daniel, of the Battersea Training College ('Modern Educational Reformers'), is unavoidably held over, and will appear in our next issue.]

Our Science Section.

CHEMISTRY NOTES.

BY W. TATE, A.R.C.S., F.C.S.

General Notes. — Influence of Moisture on Chemical Change. An important paper by H. B. Baker on this subject appeared in the Chemical Society's Journal for July last. The author had previously proved that carbon, sulphur, phosphorus, etc., can be heated in oxygen without visible combustion taking place, provided that the materials be very thoroughly deprived of moisture. In the Proceedings of the Chemical Society for 1893, p. 129, he follows up the subject by showing that perfectly dry ammonia and hydrogen chloride do not combine, when mixed no fumes of ammonium chloride are produced, and there is no contraction of volume. In the same note it is asserted that sulphur trioxide, when perfectly dry, has no action on calcium, barium, or copper monoxides, and that nitric oxide in the really dry state has no action on dry oxygen. In the July paper he gives the following conclusions from the results of further experiments:—(1) Sulphur trioxide does not combine with dry lime or dry copper oxide. (2) Dried ammonium chloride may be sublimed from a mixture of the salt with dried lime without ammonia being liberated. (3) Dried hydrogen and chlorine may be exposed to sunlight for two days without anything like complete interaction taking place. (4) Purified and dried nitric oxide and dried oxygen do not interact. (5) Hydrogen chloride when dried does not combine with dried ammonia gas. (6) Dried ammonium chloride does not dissociate when heated to 350°. (7) Nitrate of lead decomposes when dried, and the red fumes darken on heating. (8) The combustion of carbon bisulphide in dried oxygen is probably due to the previous splitting up of the substance when heated. (9) Dried potassium chlorate and silver oxide decompose on heating, giving off ordinary oxygen. (10) Ozone is produced by the electrification of dried oxygen. (11) Dried ammonia and hydrogen chloride can be partially separated from a mixture of these gases when oppositely charged plates are placed in the mixture, the ammonia passing to the negative plate and hydrogen chloride to the positive.

Nitrous oxide forms a hydrate with water, having the composition $N_2O.6H_2O$, with evolution of heat. Nitrous oxide acts on solutions of the alkali metals in liquefied ammonia as follows:

$$N_2O + N_2H_6K_2 = KNH_2 + NH_3 + KOH + N_2.$$

If the gas be still passed after decolorization of the liquid the reaction,

$$2NH_2K + N_2O = N_3K + KOH + NH_3,$$

takes place. This gives a direct method of obtaining the alkali salts of hydrazoic acid, N_3H.

The molecular weight of ferric chloride in alcoholic or ethereal solutions has been determined by the rise in boiling point of these solutions. It corresponds with the formula $FeCl_3$.

Platinum and palladium chlorides and an ammoniacal solution of silver nitrate are reduced by cold hydrogen with deposition of metal, but the reaction is slow. Potassium permanganate is also slowly reduced.

Ammonium persulphate may be used as an oxidizing agent for the separation of Chlorine, Bromine, and Iodine. The cold solution is mixed with sodium acetate and the persulphate, iodine is set free and is washed out of the solution by carbon disulphide. To separate bromine from a solution, ammonium persulphate is added, the whole heated at 70–80° and a current of air passed through for about an hour to sweep out the bromine, which is collected in a solution of sulphurous acid.

Practical Notes.—The separation of nickel and cobalt may be carried out without difficulty as follows: Dissolve the black precipitate of sulphides, supposed to consist of CoS and NiS, in hot concentrated hydrochloric acid with the addition of a few crystals of potassium chlorate. Evaporate the solution in a porcelain basin to a small bulk, thus driving off all chlorous fumes and much of the excess of acid, and neutralize the remaining acid by the cautious addition of solid sodium carbonate until a small permanent precipitate is formed. Redissolve this small precipitate by the smallest possible addition of dilute hydrochloric acid. To the clear solution add slowly a concentrated solution of potassium cyanide until the precipitate at first formed is redissolved. If a small insoluble residue does not disappear on warming, filter off the yellowish solution. Add sodium hydrate to the solution, after the latter has been boiled for several minutes, and then add bromine water to the cooled solution until orange brown in colour. Set aside for a short time, then filter off any black precipitate and wash it well with hot water; test this precipitate by the borax bead for the characteristic brownish-red coloration due to nickel, and further confirm the presence of this metal by dissolving the black precipitate in acid, boiling, and obtaining the apple-green hydrate on addition of sodium hydrate in excess. The filtrate must be evaporated to dryness and the residue tested by the borax bead; the characteristic blue bead obtained is sufficient evidence of the presence of cobalt.

Nickel and cobalt chlorides are precipitated as cyanides on the addition of potassium cyanide in accordance with the equations:

(1) $NiCl_2 + 2KCN = Ni(CN)_2 + 2KCl$,

(2) $CoCl_2 + 2KCN = Co(CN)_2 + 2KCl$.

The precipitated cyanides are dissolved in excess with formation of double salts, thus:

(3) $Ni(CN)_2 + 2KCN = Ni(CN)_2.2KCN$,

(4) $Co(CN)_2 + 2KCN = Co(CN)_2.2KCN$.

On boiling the double nickel salt remains unaltered, but the double cobalt salt is converted into potassium cobalticyanide, where the cobalt no longer plays the part of a base, but becomes a part of an acid radical, and hence does not now give the usual reactions of cobalt salts with reagents,

(5) $2\{CoC_2N_2.2KCN\} + 2KCN + 2HCN = K_6Co_2(CN)_{12} + H_2$,

the HCN will be present in the solution by the reaction of KCN on the slight excess of hydrochloric acid added in redissolving the carbonate formed during the preparation of the solution.

Sodium hydrate does not precipitate nickel from its double cyanide or cobalt from a cobalticyanide, but the former may be oxidized by hypobromites or hypochlorites, and thus precipitated from the cyanide solution. Bromine and soda in the cold form sodium hypobromite,

(6) $2NaOH + Br_2 = NaOBr + NaBr + OH_2$,

which reacts thus:

(7) $2NiC_2N_2.2KCN + NaOBr + 5H_2O = Ni_2(OH)_6 + NaBr + 4HCN + 4KCN$.

When using ferric chloride for the separation of phosphoric acid from bases, it is much better to employ the solution freshly prepared by dissolving the solid ferric chloride in cold water when required. The iron salt must only be added in slight excess. The excess will, as a rule, be only partly precipitated as basic acetate on boiling, and must be separated by the addition of ammonium chloride and ammonium hydrate in the ordinary way.

Arsenates are best precipitated by adding concentrated hydrochloric acid in excess, boiling, and passing hydrogen sulphide through the hot solution. After filtering and repeating the process until the arsenic is eliminated, the solution must be diluted with several times its bulk of distilled water, and hydrogen sulphide again passed to ensure the precipitation of tin, antimony, cadmium, and lead.

References.—Watts' 'Dictionary of Chemistry,' vol. i. pp. 731–752. The article on *Chemical Change* should be read by those students preparing for degrees or the S. and A. D. honours stage; particular attention should be given to the sections headed: Allotropic change, fractional precipitation, reduction of oxides, and contact-actions or catalysis. The reduction of ferric sulphate by zinc, magnesium, and iron (p. 736), and the reaction between H_2SO_4, $K_2Mn_2O_8$, and $H_2C_2O_4$ (p. 743) also require especial consideration. In the same volume, the article on *Affinity*, commencing on p. 67, should be read as far as the end of p. 70.

The Journal of the Chemical Society for 1894 contains the following papers interesting to students of inorganic chemistry:—

January: 'The Inertness of Quicklime' (V. H. Veley), pp. 1–8. 'Apparatus for the extraction for analysis of gases dissolved in water and other liquids' (E. B. Truman), pp. 43–51.

February: 'The Oxides of the Elements and the Periodic Law' (R. M. Deeley), pp. 106–115.

March: 'The Molecular Formulæ of some Liquids, as determined by their Molecular Surface Energy' (E. Aston and W. Ramsay), pp. 167–173. 'Metallic Derivatives of Acetylene. I. Mercuric Acetylide' (R. T. Plimpton and M. W. Travers), pp. 264–269.

April: 'Behaviour of the more Stable Oxides at High Temperatures' (A. A. Read), pp. 313–314.

'Stability of the Oxides considered in Relation to the Periodic Law' (G. H. Bailey), pp. 315–320.

June: 'Fluorplumbates and Free Fluorine' (B. Brauner), pp. 393–402.

'Oxidation of the Alkali Metals' (W. Ibolt and W. E. Sims), pp. 432–444.

'Sodium, Potassium, and Lithium Amides' (A. W. Titherley), pp. 504–522.

Questions.—Notes on questions given in our last issue.—*Adv.* (2) The approximate atomic weight is given by dividing the constant atomic heat by the specific heat, thus $\frac{6{\cdot}4}{0{\cdot}031} = 207$ approx. To establish the accurate value of the atomic weight of the metal in question, it is necessary and sufficient to determine its equivalent in well-characterized and definite compounds. By analysis or synthesis we can ascertain the amount of metal contained in a certain known weight of the compound considered, knowing the atomic weights of the other constituent elements we can infer the weight of hydrogen contained in the corresponding hydrogen compound in combination with the same weight of these other elements; the ratio of the weight of the metal to the weight of hydrogen it thus displaces is the equivalent of the metal. The accurate atomic weight is some simple multiple of this accurately determined equivalent; the approximate value 207 enables the true value to be selected from the multiples of the equivalent. *Adv.* (5) The weight of oxygen required will be that required to oxidize the carbon to CO_2 + that required to convert the hydrogen into OH_2—the weight of oxygen already present in the coal. The nitrogen and ash are not combustible, and hence do not take up oxygen. Hence weight of oxygen

$$= \left\{ \left(\frac{81{\cdot}5}{100} \times \frac{32}{12}\right) + \left(\frac{5{\cdot}0}{100} \times \frac{16}{2}\right) - \frac{5{\cdot}2}{100} \right\} \text{tons},$$

for 12 parts of carbon require 32 parts of oxygen, and 2 parts of hydrogen require 16 parts of oxygen. Each 23 parts of oxygen represent 100 parts of air, hence the weight of air is obtained by taking $\frac{100}{23} \times$ weight of oxygen required. *Hon.* (1) From the composition by weight of mercuric oxide determined experimentally, the weight of mercury combining with 16 parts by weight of oxygen may be calculated. The number representing this weight is the atomic weight of mercury, on the assumption that one atom of mercury combines with one atom of oxygen. The weight of one litre of mercury vapour at standard conditions divided by the weight of the same volume of hydrogen under the same conditions gives us the ratio of the molecular weight of mercury to that of hydrogen (by Avogadro's hypothesis); multiplying this number by two (the molecular weight of hydrogen) we have the molecular weight of mercury. The molecular weight of mercury is represented by the same number as its atomic weight, and the molecule of mercury contains one

atom (on the assumption that the hydrogen molecule contains two atoms). *Hon.* (2) The absorption coefficient of a gas in a liquid is the number representing the ratio of the volume of gas absorbed (reduced to 0° C. and 760 mm. pressure) to the volume of the absorbing liquid, *at the particular temperature of observation* and 760 mm. pressure.

Questions. — *Advanced Stage.* — (6) Describe a method of accurately determining the percentage composition of air by weight, and give your reasons for considering air to be a compound or a mixture as the case may be. (7) Give full details of methods enabling you to prove (*a*) that carbon dioxide contains its own volume of oxygen; (*b*) that sulphuretted hydrogen contains its own volume of hydrogen. (8) Give full and exact reasons for assigning the formulæ O_2, O_3, P_4, Hg, and Cd, to oxygen, ozone, phosphorus, mercury, and cadmium (1893, S. and A. D.). (9) State clearly what occurs when (*a*) water vapour, (*b*) hydrogen sulphide, (*c*) nitrous oxide, (*d*) carbon monoxide, are passed through a tube packed with iron nails and maintained at a bright red heat. What happens at ordinary temperatures with *b*, *c* and *d*? *Advanced Practical.*—(3) Why is ammonium chloride added before the addition of ammonium hydrate for the precipitation of Fe, Al, and Cr? (4) Magnesium forms a carbonate insoluble in water; why is this metal not precipitated together with the barium group by ammonium carbonate as usually employed? *Honours Stage.*—(5) Describe a method for the preparation of hydrazoic acid. What are the properties of this acid and its principal salts? (6) Discuss the chemistry of the cementation process for the production of steel. What light has been thrown on this question by recent discoveries? (7) Give some account of the services rendered to chemical science by Black, Cavendish, Priestley, and Humphrey Davy (1892, S. and A. D.). (8) Describe Lunge's Gas-volumeter, and give details of instances in which it may be employed (*a*) to determine the value of a standard volumetric solution without the use of a balance, (*b*) to ascertain the specific gravity of a finely divided solid substance which readily dissolves in ordinary liquids, (*c*) to prove that air is a mixture of gases and not a single chemical compound.

ORGANIC CHEMISTRY NOTES.

By J. T. Hewitt, M.A., D.Sc., Ph.D.,
Professor of Chemistry, People's Palace.

In choosing a text-book on inorganic chemistry one is met with the difficulty of number, text-books abounding on all sides, good, bad, and indifferent. Fortunately inferior chemists do not find the same attraction in writing organic text-books, and one's task is very much simplified in effecting a choice. For a good all-round knowledge of a not too advanced type Remsen's 'Organic Chemistry' (Macmillan, 6s.) may be recommended, whilst for the student who has overcome the initial difficulties of the science, and needs somewhat more detailed work, Bernthsen's 'Organic Chemistry' (Translation by McGowan, Blackie, 7s. 6d.) cannot be too highly praised. Smith's translation of Von Richter's Text-Book (Longman's, 21s.) may be used for reference, as also the organic part of Roscoe & Schorlemmer's Treatise and Beilstein's 'Handbuch der Organischen Chemie' by such students who can read German. In fact a knowledge of German is of the greatest importance to the more advanced organic students, since probably 80 or 90 per cent. of the organic work published appears in the German journals ('Berichte,' 'Annalen,' &c.).

Besides the work the advanced student has previously done for the elementary stage, he must have a knowledge of the chemistry of the aromatic hydrocarbons and their derivatives. These compounds, although not of the type $C_n H_{2n+2}$, behave in most respects as if they were saturated substances, so resembling the paraffins, from which they differ, however, by their greater reactivity. Thus a paraffin is not acted on by nitric or sulphuric acids as a general rule, but with benzene or its homologues we get substitution taking place and one or more hydrogen atoms replaced by nitro- or sulphonic-acid groups.

Thus from benzene we get—

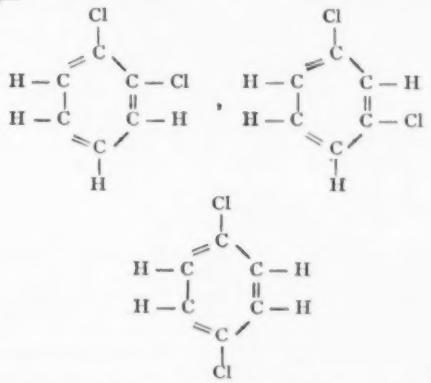
$$C_6H_6 + HNO_3 = C_6H_5NO_2 + H_2O$$
$$\text{or } C_6H_6 + H_2SO_4 = C_6H_5SO_3H + H_2O.$$

i.e. nitrobenzene or benzene-sulphonic acid, according to whether we have used nitric or sulphuric acid.

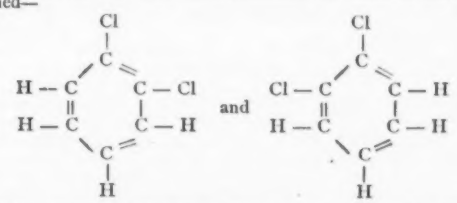
Again, we observe a peculiar isomerism in the aromatic series, all the hydrogen atoms in benzene, C_6H_6 are to start with of equal value, and we can only obtain one derivative of the type C_6H_5X, *i.e.* we only know one monochlorobenzene C_6H_5Cl, one aniline $C_6H_5NH_2$, &c.

When two hydrogen atoms are replaced, we have isomerism making its appearance, we know three dibromobenzenes $C_6H_4Br_2$, three phenylenediamines $C_6H_4(NH_2)_2$, three chloranilines $C_6H_4Cl\,NH_2$. So a substance of the type $C_6H_3X_3$ can exist in three modifications, and we also know three modifications of a substance of the type $C_6H_2X_4$ (*e.g.* $C_6H_2(CH_3)_4$).

This isomerism was first explained by Kekulé, nearly 30 years ago; he supposed the six carbon atoms were arranged in a ring and connected by alternate single and double linkages, thus $C_6H_4Cl_2$ may be—

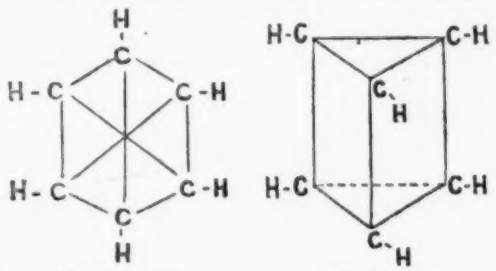


It has been urged against this formula that there should be two ortho derivatives, two ortho chlorobenzenes for example might be imagined—



Another stronger objection is that benzene only under certain circumstances acts as an unsaturated compound; it usually gives substitution instead of addition products.

To obviate this difficulty other formulæ have been proposed, the

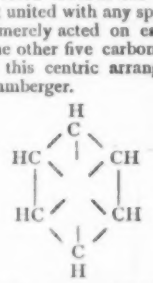


Ladenburg's formula. Claus' formula.

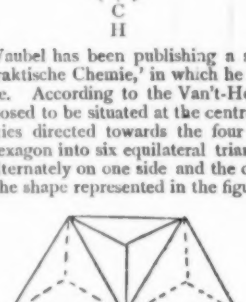
prism formula of Ladenburg being the first attempt to represent the benzene molecule in space. The formula proposed by Claus is

also a symmetrical formula, in which the carbon atoms are represented as united by single linkages only.

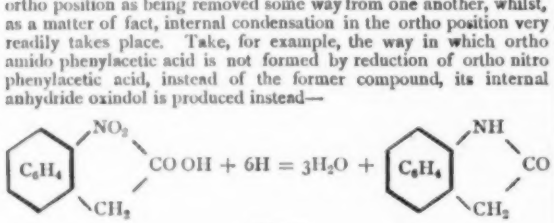
V. Baeyer proposed a centric formula in which the carbon atoms were represented as being united by single linkages, but each carbon atom had a linkage directed towards the centre of the molecule, which, however, was not united with any specified linkage from any other carbon atom, but merely acted on each one of the similarly situated linkages from the other five carbon atoms. V. Baeyer has himself rather dropped this centric arrangement; it is, however, strongly supported by Bamberger.



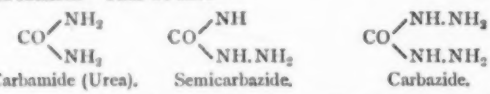
Quite recently, Vaubel has been publishing a series of papers in the 'Journal für Praktische Chemie,' in which he supports a special formula for benzene. According to the Van't-Hoff hypothesis, the carbon atom is supposed to be situated at the centre of a tetrahedron, with its four valencies directed towards the four corners. Vaubel divides a regular hexagon into six equilateral triangles, on which he erects tetrahedra alternately on one side and the other; his formula for benzene takes the shape represented in the figure—



Objection may be taken to this, that it represents atoms in the ortho position as being removed some way from one another, whilst, as a matter of fact, internal condensation in the ortho position very readily takes place. Take, for example, the way in which ortho amido phenylacetic acid is not formed by reduction of ortho nitro phenylacetic acid, instead of the former compound, its internal anhydride oxindol is produced instead—

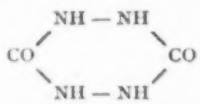


Amongst the papers that have been recently appearing on organic chemistry, those on compounds containing nitrogen are the most interesting. Hydrazine, N_2H_4, must be regarded as an inorganic compound as it contains no carbon, its most interesting derivatives are, however, organic. Hydrazine forms hydrazides, just as ammonia gives rise to amides by replacement of hydrogen atoms by acid radicles. Thus we have—

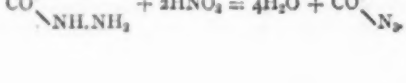


Carbamide (Urea). Semicarbazide. Carbazide.

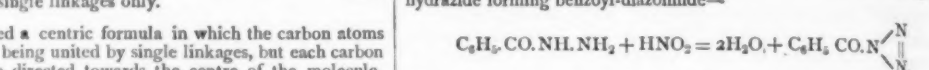
Professor Curtius has just described a dihydrazide derived from two carboryl residues, and two molecules of hydrazine; it has a ring formula—



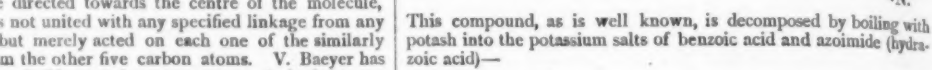
In the same paper (the current number of the 'Berichte') Professor Curtius describes the action of nitrous acid on carbazide, a compound of the formula $CO.N_6$ is produced according to the equation—



This corresponds to the way in which nitrous acid acts on benzoyl hydrazide forming benzoyl-diazoimide—



This compound, as is well known, is decomposed by boiling with potash into the potassium salts of benzoic acid and azoimide (hydrazoic acid)—



In the same way, hydrolysis of the compound $CO.N_6$ yields carbonic acid and azoimide.

The honours student is advised to read up methods by which the orientation of benzene compounds has been determined; a fair account is given in the introductory portion to the aromatic compounds in Roscoe & Schorlemmer's 'Treatise on Chemistry,' Vol. 3, Part 3., and the new edition of Bernthsen's 'Text-book of Organic Chemistry,' pp. 335–355.

HONOURS PHYSIOGRAPHY NOTES.

BY R. A. GREGORY, F.R.A.S.,

Oxford University Extension Lecturer, Author of 'Elementary Physiography,' &c.,

AND A. M. DAVIES, B.SC. (LOND.), F.G.S.

Late Demonstrator in Geology at the Royal College of Science.

IT may be worth while to remind students that the notes in these columns must be regarded as supplementary to the information given in 'Honours Physiography.' Everyone working up for the examination in Honours Physiography should understand that we assume that they are familiar with the subjects dealt with, not only in 'Honours Physiography,' but also in the Elementary and Advanced books of the same series. All that we can do in these notes is to direct attention to recent developments. We summarise or state the chief results of every important research on a subject which we think may be used to base a question upon for the Physiography examination paper. In fact, we bring together in a condensed form everything which we should read ourselves if we were again going to sit for the examination. It is, of course, possible, but not probable, that some subjects of physiographical interest may be overlooked by us. If any teachers or students should require information upon such a subject, let him write to us. It frequently happens that teachers of physiography do not know where to obtain an explanation or description of some points pertaining to their subject. Again, we say, write to us. Let us be consulting physiographers. Our business in life necessitates our being in touch with all the sciences comprehended by physiography, and it will give us pleasure to help those who have a difficulty in obtaining information upon any matter within our purview.

In April of this year we briefly described Prof. Langley's Colometer and some of the results obtained with it during the last two or three years. There is a paper by Prof. Langley on 'Recent Researches in the Infra-Red Spectrum,' in *Nature* of November 1. It is hardly necessary for students to take in all the paper contains, nevertheless they would do well to glance through it. The note in the April number of the PRACTICAL TEACHER states briefly all that a candidate for Honours Physiography can be expected to know.

The Italian astronomer Schiaparelli came to the conclusion, about four years ago, that Venus rotated on her axis in the same time that she revolved round the sun, viz. 225 days. (See 'Honours Physiography,' p. 63). This has, however, since been disputed by several trustworthy observers, and M. Flammarion, the well-known French astronomer, has just ranged himself on the side of the opposition. Eight years' observation of the markings on the planet has led him to the opinion that the rotation period is about twenty-four hours.

VARIATIONS OF TERRESTRIAL LATITUDE.

The variations in the observed latitude of a single place have been referred to from time to time in these notes, and are described in 'Honours Physiography' (p. 116). We return to the subject for two reasons: firstly, because a question upon it may again reasonably be expected in the Honours Physiography examination paper; and secondly, because Prof. Foerster has recently given a statement of most important results bearing upon it. Prof. Foerster's paper

is reprinted in *Nature* of September 13, and the following is an abstract of it :—

'The mathematicians of the eighteenth century profoundly investigated the full theory of free rotation of a solid system of masses, under the action of various disturbing influences, not only those acting from outwards on the rotating body (as in the case of the sun's and the moon's attractions on the earth), but also those depending upon the condition or changes within the rotating system itself. It was then calculated that the slightest deviation of the rotational axis of the earth from the principal axis of inertia has the consequence that the pole of the rotational axis begins and continues to describe a small circle round the pole of the principal axis.

'Now all such displacements, possibly measurable with reference to fixed directions in the earth, and insensible with reference to fixed directions in space, could be found in the most favourable way by measuring as exactly and continuously as possible the distance of the pole from the zenith of the observer's station; in other words, by repeated determinations of the geographical latitudes. But, notwithstanding very long and refined determinations of the geographical latitudes at some of the principal observatories, beginning shortly before the middle of the present century, only very uncertain and discordant traces of the phenomena in question were found.

'The reason for this want of success is now very clear. Astronomers had limited their researches too narrowly to a supposed regular ten-monthly periodical movement of the pole of the rotational axis around the pole of the principal axis. Too easily it had been admitted that all the existing variations of the distribution of terrestrial masses were by far too small for altering sensibly the position of this principal axis itself.

'It was Lord Kelvin, at the Glasgow meeting of the British Association (1874), who at first drew the attention of the scientific world to the consideration of the great natural transports of masses of air and water and various masses by the water, going on continuously and periodically in the forms of currents and circulations of different kinds, as well in the atmosphere as in oceans and rivers; for instance, the enormous periodical sediments of snow and ice. He showed that these very considerable variations of the distribution of masses on the earth could not only produce sensible displacements of the principal axis of inertia, but that such displacements of this axis could have an amplifying effect on the total amount of displacements of the rotational axis.

'The field of this research was thus decisively cleared by the veritably releasing ideas of Lord Kelvin. Finally, about four years ago, by the co-operation of some observatories with the International Geodetic Union, clear evidence was obtained, and in the last three years, with the aid of an expedition sent by the International Union to Honolulu, decisive proofs of such displacements have been found.

'The accompanying diagram (Fig. 1) shows these newest results. It represents the wanderings of the pole of the rotational axis of the earth on the surface of the latter from October, 1892, to May, 1894.

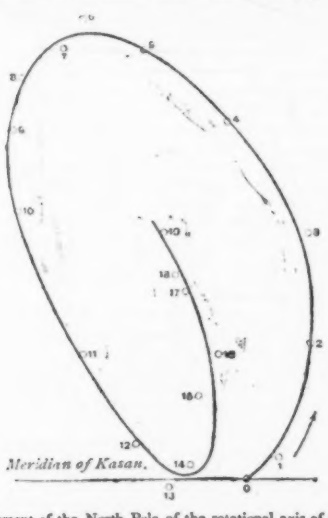


Fig. 1.—Movement of the North Pole of the rotational axis of the earth. The centres of the numbered circles represent the calculated positions of the pole on different dates from October 1892 to March 1894.

'This sketch is founded on nearly 6,000 single determinations of latitude made in the Observatory of Kasan (Eastern Russia), Strassburg (Elsass), and Bethlehem (Pennsylvania). The observations are condensed in twenty monthly mean results, numbered from zero to nineteen. Every one of these resulting monthly positions of the pole indicated by the centres of the small circles is thus the mean result of about 300 single determinations.

'The figure is drawn on a scale of two millimetres to one-hundredth of a second of arc, and the maximum amplitude of the curve is nearly 50-hundredths, or half a second. The amplitude of these movements of the pole on the surface of the earth is between 40 and 50 feet.

'The general character of the movement is quite in accordance with what has been mentioned concerning its complicated and somewhat spiral character. The sense of the motion is turning from west to east. The velocity is apparently very variable, and it seems as if we now approach an epoch in which the amplitude considerably diminishes.'

Synopsis of Observations of Mars.

The following synopsis of observations of Mars, taken from an article contributed by Prof. W. H. Pickering to the American journal *Astronomy and Astro-Physics*, shows in a very compact manner the development of knowledge of the principal features of the planet's surface. It is, of course, unnecessary to commit the dates to memory, but attention should be paid to the general run of the discoveries, as only points of importance are included in the synopsis.

272 B.C.—The first known observation of Mars is recorded in Ptolemy's Almagest.

1610.—The phases of Mars were discovered by Galileo.

1659.—The first sketch showing surface detail was made by Huyghens. He also suggested a rotation in 24 hours.

1666.—Cassini determined the rotation of Mars to take place in 24 hours 40 minutes. He also observed the polar caps.

1777.—With the exception of Huyghens, Hooke, and possibly Maraldi, no one succeeded in making recognisable sketches of the surface detail upon Mars for over a century, until Sir William Herschel took the matter up in this year.

1783.—Sir William Herschel detected the variation of the size of the polar snow caps with the seasons, measured the polar compression, and determined the inclination of the axis of the planet to its orbit.

1785–1802.—Schroeter made an extended study of the planet. His drawings are upon the whole rather better than those of Herschel. He discovered, among other things, a number of very dark spots in the Northern and Equatorial Seas.

1840.—Beer and Maedler published the first map of the planet, assigning latitudes and longitudes to the various markings. On this map are indicated the first canals, and the first of the small lakes, so many of which have been discovered during the last few years. Their map was the first satisfactory representation of the entire surface of the planet.

1858.—Secchi made a careful study of the colours exhibited by the planet.

1862.—Lockyer made the first series of really good sketches of the planet, showing all the characteristic forms with which we are now so familiar.

1864.—Dawes detected eight or ten of the canals.

1867.—Huggins detected lines due to the presence of water vapour in the spectrum of Mars.

1867.—Proctor determined the period of rotation of Mars within 0·1 second.

1877.—Hall discovered the two satellites of Mars.

1877.—Green made a very excellent series of drawings of the planet, superior to anything which had preceded them.

1877.—Schiaparelli made the first extensive triangulation of the surface of the planet, and added very largely to the number of known canals.

1879.—Schiaparelli detected the first known double canal.

1882.—Schiaparelli discovered numerous double canals, and announced that the appearance formed one of the characteristic phenomena of the planet.

Since 1882, astronomers have directed their observations chiefly to the canals, the existence of which may now be taken as definitely established.

The Differentiation of Igneous Rocks.

In recent years much attention has been given by geologists to the problems connected with the origin of igneous rocks, and especially to the explanation of their resemblances and diversities in chemical composition, and the peculiarities of their geographical distribution. The following are some of the most important generalizations that have been made on these points :—

(1) During a particular period of volcanic activity in a district, lavas of widely differing chemical composition are erupted at different times. It is usual to find lavas of both acid and basic composition, *i.e.*, lavas with a high percentage of silica, alumina and potash (acid) on the one hand, and with a high percentage of

iron, magnesia, and lime (basic) on the other, the one group of substances increasing as the other diminishes.

(2) When, however, two simultaneously active districts are compared, it is often found that while in each district there is a very similar *range* of composition of the lavas, yet those of one district are united by the possession of certain features by which *as a whole* they may be contrasted with those of the other region. The distinctive features are seen in the average composition after allowance is made for the reciprocal variations in the above-mentioned constituents; they often take the form of special abundance of one constituent—soda, for example, in the modern lavas of Pantelleria—and apart from actual chemical analysis they show themselves by the development of special and characteristic minerals. The classical instance of 'petrographical provinces,' as such districts are called, is that of Hungary and Bohemia, described by Judd, two countries only separated by the range of the Carpathians, but characterized by very distinct, though parallel, series of eruptive rocks. Another striking instance, according to Iddings, is the American continent, separated by the Rockies and Andes into a *western* region in which there is a deficiency of alkalies and an abundance of magnesia and iron, and where hypersthene is consequently a frequent mineral, and an *eastern* in which these relative conditions are reversed, and the minerals leucite and nepheline are abundant.

(3) A parallel condition to that obtaining in the *volcanic* rocks is often, but not always, to be found in the *plutonic* rocks of a district. Plutonic masses are often found to gradually change their composition when traced from point to point, while at the same time often retaining some one or more characters over their whole area. Thus Bayley has described, in Minnesota, a mass of gabbro, varying greatly in composition from place to place, but everywhere containing the same species of felspar. The occurrence of plutonic rocks of very different composition side by side is common. In certain 'plutonic complexes' rocks so acid as granite and so basic as peridotite are found together, and on a smaller scale the same phenomenon is shown in the familiar 'enclosures' or 'segregations,' usually of more basic material, and the 'contemporaneous veins,' usually of more acid material, that are found in many plutonic rocks.

(4) On a small scale similar phenomena to these last are seen in *dykes*, which often show a difference in composition between centre and margin.

(5) In many of the cases mentioned, when the relative age of the several rocks in the same district can be determined, a regular order of sequence in time can be found. As a very general rule the order of sequence of volcanic rocks is (i.) intermediate, (ii.) basic, (iii.) acid; though (ii.) and (iii.) may be reversed, *e.g.*, in the North Wales Ordovician lavas; and (i.) may be absent, as in Iceland. In the case of plutonic rocks, regularly increasing acidity is the rule; but it is not without exceptions.

This time-sequence, it must be understood, refers only to a particular period of volcanic activity, not to geological time as a whole, during which the sequence may be repeated several times in a particular area, as in the case of the eruptions of the Old Red Sandstone and Carboniferous periods in Scotland. The old notion that the Palæozoic igneous rocks were quite different from those of Tertiary and recent date is now generally abandoned.

These facts must have some general explanation. The old one, suggested by Bunsen and Durocher, was the existence of two molten rock-magmas (local or universal) of acid and basic composition respectively, by the mixture of which all the varieties were formed. This idea has now been abandoned, and the view is becoming more and more general that in reality a process the reverse of this takes place—that a single molten rock-magma gives rise by differentiation during cooling to all the varieties that are erupted during a particular period in a particular district. There are two sets of considerations which support this view—one drawn from observations of the actual differentiation of rocks on a small scale; the other on abstract physical principles. Among the first we may take the following:—

(1) It is well known that the minerals in rocks do not all crystallize simultaneously, but in a regular sequence, which can be determined for any given rock by microscopic and other examination. The earliest-formed minerals, being surrounded by liquid, have their proper crystallization least interfered with, and so are found in well-developed crystal forms, *i.e.*, are *idiomorphic;* while the last minerals to crystallize out can only fill up the interspaces between those already in existence, and so have no chance of assuming their proper outlines, *i.e.*, are *allotriomorphic;* or (in the case of lavas) much residual material may even solidify in an amorphous or semi-amorphous condition. An earlier-formed crystal may also often be *enclosed* in a later one.

(2) The order of solidification of minerals is not quite constant, and *is not the descending order of fusibility;* thus quartz, one of the most infusible of minerals, is one of the last to solidify. But, generally speaking, minerals crystallize out from a rock in the order of *increasing acidity;* oxides, like magnetite, separate out first, then come basic silicates, then acid silicates, and then quartz. It follows that during the process of crystallization the residual liquid portion of the rock-magma is becoming more and more acid.

(3) In the case of minerals like augite and felspar, which have a wide range of possible composition (or, to be strict, which include a large group of isomorphous minerals) a progressive change in composition from centre to circumference is often found, both in volcanic and plutonic rocks. The central portion is the most basic, and generally forms a definite kernel, outside which there is *usually* a gradual passage to more and more acid layers. This is seen in sections under the microscope as an optical *zoning.* (It must be remembered that there are other forms of zoning, due to enclosures, to occasional corrosion by the magma, &c., which are due to irregularities in the growth. It must also be borne in mind that growth, accompanied by zoning, is not confined to a crystal in a liquid magma, but may continue, under certain circumstances, in the solid rock, when there is amorphous material of suitable composition around the crystal.)

(4) Segregations on a small scale are not uncommon in a volcanic rock, especially segregations of crystals of the more basic minerals. Here we are dealing with cases very similar to, though on a smaller scale than, those of some dykes, where the basic materials are segregated towards the margin. The fact that the order of crystallization is not the descending order of fusibility, but rather the reverse (for basic rocks are much more easily fusible than acid ones), shows on the one hand that much complication in results might be expected from an interruption to the uniform cooling; and on the other hand it indicates the physical laws of liquid mixtures, and especially of solutions, as the region in which the clue must be sought.

Much new information on the molecular physics of solutions has been obtained in recent times from the researches of Van t' Hoff and others on osmotic pressure. Unfortunately the work has as yet been done only on dilute saline solutions; that is to say, liquid mixtures of only two substances, in which the solvent (or liquid with the lower melting-point) is in great excess. Consequently caution is very necessary in applying generalizations thus obtained to the rather different case of rock-magmas, which are complex mixtures of molten silicates.

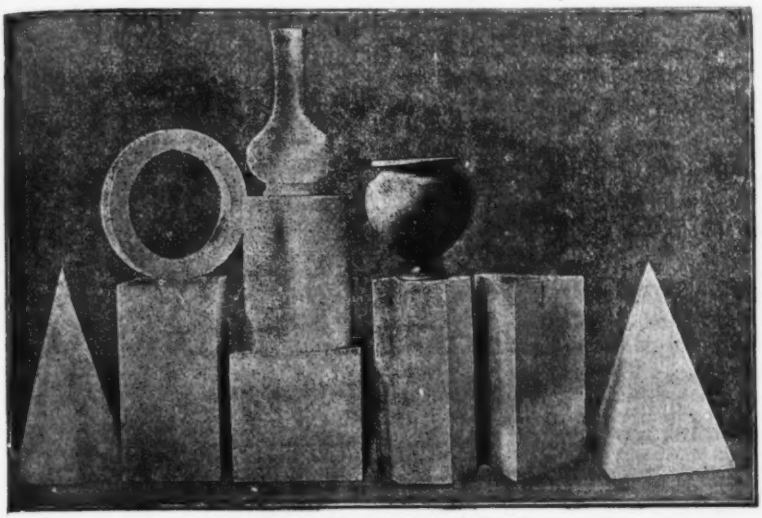
(1) Guthrie long ago showed in the case of saline solutions that if the two constituents (the salt and water) are present in certain proportions, they will consolidate simultaneously at a definite temperature: a mixture in such proportions he called 'eutectic.' If either of the constituents is somewhat in excess of those proportions, as the temperature falls it will gradually separate out in the crystalline form, until at the proper temperature for the simultaneous crystallization the mixture is left of eutectic proportions, and the simultaneous crystallization takes place. Thus the order of solidification of the two constituents is determined, not by their relative melting-points, but by the proportions in which they are present. This is enough to show that the late crystallization of quartz, mentioned above, is not as anomalous as it seems at first sight. Teall has applied Guthrie's principle to the case of quartz and orthoclase, which are the last minerals to solidify in acid rocks, and which often do so simultaneously, producing the remarkable intergrowths called 'graphic' and 'micropegmatitic.' From several analyses of 'micropegmatite' he has shown that it is probable there is a definite 'eutectic' proportion between the two constituents, quartz and felspar.

(2) Another principle, known as Soret's, has been applied to explain the differentiation of magmas. This principle is that when the temperature of a solution ceases to be uniform, the substance or substances with which the solution is most nearly saturated tend to concentrate in the cooler parts, the concentration varying inversely as the absolute temperature.

(3) A Norwegian geologist, Backström, has recently insisted that the case of rock-magmas is to be regarded rather as subject to the laws of the miscibility of liquids than those of solutions—though whether this is a real distinction may be questioned. Miscibility is a function of temperature, and, by cooling, a homogeneous mixture may tend to separate into two or more layers, according to the relative densities of the components.

(4) It has also been suggested that minerals like magnetite may (after crystallization) tend to segregate through magnetic attraction. Professor Rücker, however, has shown that at high temperatures the magnetism of magnetite disappears. This cannot therefore be accepted as a factor of segregation.

The student will see that the subject is by no means settled, and important advances in the explanation of magma-differentiation may be expected in the future. For the present it is sufficient to keep the above principles in mind, noting that they show two possible ways of differentiation—differentiation of a purely liquid magma before crystallization begins, and differentiation in which the separa-



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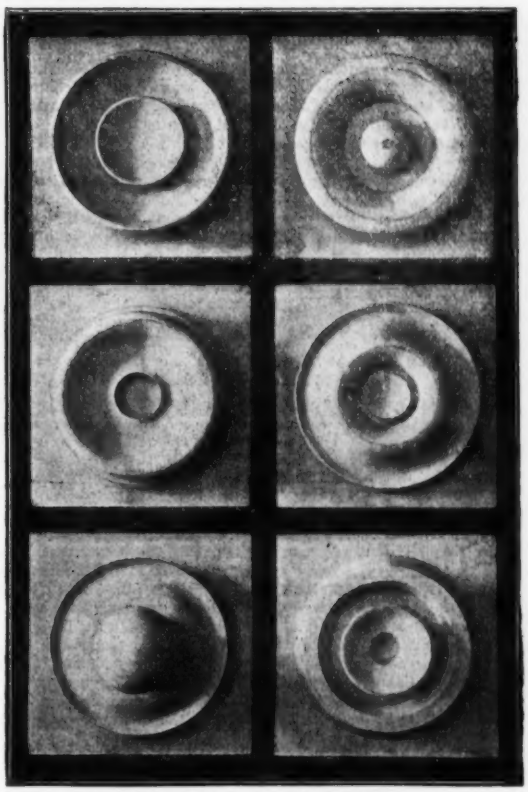

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tion of crystals is a factor. It is important also to remember that whether the explanations suggested as to the method of differentiation are correct or not, the differentiation itself is an undoubted fact.

Two of the most striking cases recently described may be mentioned. Barrow has described in the Southern Highlands of Scotland an ancient acid intrusion of gneissic structure, and has shown that it is probable that after crystallization had proceeded to a great extent the residual liquid magma (or 'mother-liquor') was by earth-pressures squeezed out and forced into the overlying rocks, where it consolidated as the coarse veins of 'giant-granite,' which are so abundant there, and which consist of enormous crystals of quartz, microcline, and muscovite—minerals with an abundance of those constituents (silica, alumina, and potash) which are the last to solidify.

Again, in the Christiania district, Professor Brögger has investigated the origin of the wonderful variety of eruptive rocks there developed. The region is a great faulted inlier of Palæozoic rocks amid the Archæan mass of Scandinavia. There is a very complete sequence from the Cambrian up to the Old Red Sandstone (though one very much thinner than that of Wales, probably from its being of deeper-water origin). During the great earth-movements of Old Red Sandstone times, it seems to have sunk down bodily, and as it gradually subsided the underlying molten rock-magma was squeezed up to form a great series of eruptive rocks. Professor Brögger has tried to show that all these are differentiated magmas from one original source. In a recent paper he deals in detail with the basic rocks, and shows how a basic magma (itself an early product of the original magma) has consolidated in large masses without differentiation as an olivine-gabbro-diabase, while two sets of dykes and intrusive sheets, consisting of 'bostonite' (a variety of 'lamprophyre' or fine-grained diorite) and 'camptonite' (allied to trachyte) respectively, are derived from its differentiation, while there is a third set of dykes of composition almost or quite identical with the undifferentiated mass. The bostonite and camptonite he calls 'complementary rocks,' as a mixture of the two in certain definite proportions would have the composition of the undifferentiated magma. The same magma has also under other conditions differentiated *in a different way* into pyroxenite and augite-diorite. The whole of these basic rocks Professor Brögger regards as the oldest erupted of the whole series, or as the first products of the differentiation of the general magma of the district. The characters of the sedimentary rocks into which they are intruded are particularly well-adapted for the determination of relative age, and future descriptions of the other rocks of the great series may be expected to be of further interest and importance.

MATHEMATICS.

STAGES 2 AND 3, SCIENCE AND ART DEPARTMENT.

By G. A. Baxandall,

Assistant Mathematical Instructor, Royal College of Science, London.

There can be little doubt that a student receives great assistance from the solutions to a carefully selected group of typical examples. But a teacher in setting such a task should not be content with merely working out such examples; it is alike his privilege and duty to explain, whenever possible, the reasons for the steps he takes, and thus attempt to direct the student into the line of thought which he himself employs. Further, a good teacher will train his students to observe the *form* which expressions assume, as this will often lead to shorter and neater solutions. Though want of space will often prevent the writer from treating the solutions so fully as he would wish, students will find that the examples and solutions given refer to points that most require elucidation.

Stage 2.

Algebra.

Solutions to a few examples set last month are now given:—

Ex. 5.—Find the square root of

$$\{(3x+2y)^2+(x-4y)^2\}^2-4(3x+2y)^2(x-4y)^2.$$

Observing the form of this expression we see that by putting $a=(3x+2y)^2$ and $b=(x-4y)^2$ it reduces to $(a+b)^2-4ab=a^2-2ab+b^2$, and hence the square root is $a-b$, or $(3x+2y)^2-(x-4y)^2$, that is $8x^2+20xy-12y^2$.

Ex. 10.—If $2x-5=\sqrt{13}$ find the value of

$$\frac{(x-5)(x-1)}{(x-3)}.$$

Always see if the expression will simplify; here little can be done, therefore substitute at once.

$$2x-5=\sqrt{13} \text{ or } x=\frac{\sqrt{13}+5}{2},$$

$$\therefore \frac{(x-5)(x-1)}{(x-3)}=\frac{\left(\frac{\sqrt{13}+5}{2}-5\right)\left(\frac{\sqrt{13}+5}{2}-1\right)}{\frac{\sqrt{13}+5}{2}-3}$$

$$=\frac{(\sqrt{13}-5)(\sqrt{13}+3)}{2(\sqrt{13}-1)}=-\frac{2+\sqrt{13}}{2(\sqrt{13}-1}$$

$$=-\frac{\sqrt{13}+2}{2(\sqrt{13}-1)}\times\frac{\sqrt{13}+1}{\sqrt{13}+1}=-\frac{\sqrt{13}+7}{6}.$$

Work the following examples:—

11. Find the value of $\sqrt{\left(\frac{\sqrt{5}-2}{\sqrt{5}+2}\right)}$ to 3 places of decimals. Ans. 0·236.

12. Simplify $\left(\frac{x^5-1}{x-1}\right)^2-\left(\frac{x^5+1}{x+1}\right)^2$ and get the numerical value if $x\sqrt{(2+\sqrt{3})}=1$.

Answers. $4x(x^2+1)(x^4+x^2+1)$; $2\sqrt{2}(33-19\sqrt{3})$.

13. Which is greater, $\sqrt{3}$ or $\sqrt[3]{5\frac{1}{2}}$? Ans. The latter.

14. Find, in its simplest form, the product of $\sqrt{6}-\sqrt{2}$ and $\sqrt{2}+\sqrt{3}+\sqrt{\frac{2}{3}}$. Ans. $2+3\sqrt{2}(\sqrt{3}-1)$.

15. Simplify $\sqrt{(52-7\sqrt{12})}$ and extract the square root of $11+4\sqrt{6}$. (See Text book).

Answers. $7+\sqrt{3}$; $2\sqrt{2}+\sqrt{3}$.

16. Find the value of $\frac{1+2\sqrt{x}}{1-\sqrt{x}}-\frac{1-\sqrt{x}}{1+2\sqrt{x}}$ when $3x=1$ and $\sqrt{3}=1\cdot73205$. Ans. 4·9019.

Example.—Show without extracting square roots that $\sqrt{17}+\sqrt{19}$ is less than $6\sqrt{2}$.

Solution.—While the expressions are in their present form we cannot tell by inspection which is the greater. Try squaring each and we get $(36+2\sqrt{17\times19})$ and 72. The former of which is the smaller if $2\sqrt{17\times19}$ is less than 36, but this is the case, since $2\sqrt{17\times19}=2\sqrt{(18-1)(18+1)}=2\sqrt{18^2-1}$ which by inspection is less than 2×18, or 36.

Read Chapter XIX. on Quadratic Equations in H.S.* or Chapter XXVI. of H. K. In the former, Articles 235 and 239 give the general method of solution and the necessary precautions to be taken before applying it. The student should also notice that different articles are devoted to different *cases*, but the *method* is the same in each. There are two distinct methods of solving quadratic equations, only one of which is given in H. S., but we may explain the other by a few examples:—

1. Solve $x^2-2x=15$. Bring every term to the left-hand side—thus, $x^2-2x-15=0$, and find the factors, giving us $(x-5)(x+3)=0$. Since the product of these factors is zero, it is necessary (and sufficient) that *one* should be zero. Hence we get that either

$$x-5=0 \text{ or } x+3=0,$$

$$i.e., \quad x=5 \text{ or } x=-3.$$

2. Solve $\frac{6}{x}+\frac{x}{6}=\frac{5(x-1)}{4}$.

Simplify and we get $72+2x^2=15x^2-15x$,

or $13x^2-15x-72=0$,

$i.e.$ $(13x+24)(x-3)=0$;

hence $13x+24=0$, or $x-3=0$,

$\therefore x=-\frac{24}{13}$ or $x=3$.

This method is given in H. K., and may be strongly recommended for use in cases where the numbers are not too large. At the same time it is not the most general method. Avoid the method of solving by means of the formula given in Art. 199, H. K.

* We shall use H.K. for Hall and Knight, H.S. for Hamblin Smith, Tod. for Todhunter. ${}_7C_2$ represents the number of combinations of 7 things 2 at a time.

Work out a few from each of the sets given in the text-book, and also the following:—

17. (1) $\frac{3}{x+10}-\frac{2}{x-15}=\frac{2}{x}$.

(2) $4x^2-x=7\cdot5$.

(3) $37x^2-57x=34$.

(4) $x^2-2x\sqrt{3}+2=0$.

(5) $40(x+\frac{1}{x})^2-286(x+\frac{1}{x})+493=0$.

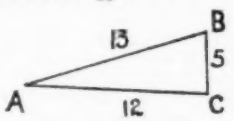
(6) $x^2+\frac{9}{x^2}-4(x+\frac{3}{x})-6=0$.

Answers. (1) 5, or -60; (2) $\frac{3}{4}$, or $-\frac{2}{5}$; (3) 2, or $-\frac{17}{37}$; (4) $\sqrt{3}+1$, or $\sqrt{3}-1$; (5) $\frac{2}{5}$, $\frac{5}{2}$, $\frac{1}{4}$, or 4; (6) $3+\sqrt{6}$.

Also H. S., Ex. XCVIII. 9, 24, or H. K., Ex. XXVII. 4, 18.

Trigonometry.

Students of trigonometry frequently complain that there are so many formulæ to commit to memory. There are, however, different ways of *learning* formulæ. If anything must be learnt 'parrot-like,' we shall say so, but we shall also endeavour to assist the student in acquiring the habit of connecting formulæ and making them depend on those which are fundamental. We have already asked the students to learn the definitions of the trigonometrical ratios; the definition of the circular measure of an angle may go side by side with these. Here we have an example of learning in the same way as the alphabet is learnt, and no progress can be made until they are committed to memory. This having been done, let us examine what can be done with them. If the value of one ratio be given, it is equivalent to having given two sides of a right-angled triangle, and it will be clear that since we can determine the third side, it is possible to find the values of all the other ratios. For example, suppose $\cos A=\frac{12}{13}$, then



AC = 12, AB = 13, ∴ BC = $\sqrt{13^2-12^2}=5$;

hence $\sin A=\frac{5}{13}$, $\tan A=\frac{5}{12}$, $\operatorname{cosec} A=\frac{13}{5}$, and so on.

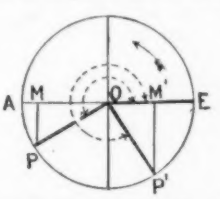
Work out Examples XVIII., H. S., or Examples XVII., Lock.

Read Art. 93, H. S., or Art. 111, Lock, and

Work out Examples XVII., H. S., or Examples XVI., Lock.

Read carefully Chapter V., H. S., or VIII., Lock.

By means of the four figures in Art. 51, H. S., the definitions of the trigonometrical ratios are made to apply to angles which are greater than 90° as well as to acute angles. This is not the case in Lock, Art. 75, but he extends the definition in Articles 132, 133. Thus, if a line OP start from the initial position OE, and rotate in the direction of arrow to OP, the sine of EOP = $\frac{PM}{OP}$, but if, for



example, OP were 6 units, and PM actually 3 units in length, sine EOP would *not* = $\frac{3}{6}$, but $\frac{-3}{6}$ or $-\frac{1}{2}$, since PM is negative if it falls below AE. Similarly, if the revolving line had moved further, say to OP', the tangent of EOP' would be $\frac{P'M'}{OM'}$, and if P'M' were actually 5 units in length and OM' 3 units, then $\tan EOP'=\frac{-5}{3}=-\frac{5}{3}$ since P'M' is negative and OM' positive. Similarly, since OM would actually be $3\sqrt{3}$ units, $\tan EOP=\frac{-3}{-3\sqrt{3}}=+\frac{1}{\sqrt{3}}$, PM and OM each being negative.

Work the following examples:—

7. Draw figures similar to the above showing as accurately as you can the two positions of OP when the angle described is such that its sine is $\frac{1}{3}$, and also when it is $-\frac{2}{3}$. Indicate the two positions of OP when the angle (θ) is such that $\tan\theta+1=0$.

8. Obtain the values of the cosines of all the angles in last example, paying careful attention to their signs.

Answers. $\frac{\sqrt{3}}{2}$, $-\frac{\sqrt{3}}{2}$; $-\frac{4}{5}$, $\frac{4}{5}$; $-\frac{1}{\sqrt{2}}$, $\frac{1}{\sqrt{2}}$.

9. If $\tan 26°\,34'=\frac{1}{2}$, write down and show by a figure the two angles less than 360° whose tangents are each $-\frac{1}{2}$.

Answers. 153° 26' and 333° 26'.

10. Why is it absurd to say that 2 sin A = 3, or that 3 sec B = 2?

11. Write down the *signs* of the following ratios: sin 120°, cos 140°, tan 250°, sec 300°, cosec 330°, by using a figure, and find out which of the first two is the greater numerically, and which of the last two.

12. If $\tan\theta=\frac{1}{\sqrt{7}}$ find the value of $\frac{\operatorname{cosec}^2\theta-\sec^2\theta}{\operatorname{cosec}^2\theta+\sec^2\theta}$.

Ans. $\frac{3}{4}$.

Geometry.

Read the propositions 9 to 14, Book II. The last four are important. Want of space prevents us giving solutions to the riders of last month, but they are readily obtained from a figure.

STAGE 3.

Algebra.

Solution to Ex. 4.—First ensure that a is chosen twice; this can be done in ${}_7C_2=\frac{7.6}{1.2}=21$ ways. Suppose this operation is performed in any one of these ways; for example, by taking an a from each of the first two groups. Now go to a third group and choose one letter; this can be done in 10 ways only, since an a may not be chosen; hence by our fundamental principle there are 21×10 ways of selecting 2 a's and another letter. In this way it should be clear that by going to a fourth group and choosing a letter, then to a fifth, and so on for each of the seven groups, the required number of ways = 21×10^5, or ${}_7C_2\times(11-1)^{7-2}$. For the last part of example put m for 7, n for 11, and p for 2, thus getting

$$ {}_mC_p\times(n-1)^{m-p}=\frac{\lfloor m}{\lfloor p\ \lfloor m-p}\times(n-1)^{m-p}. \quad (1891.)$$

Example.—Twelve cards are marked A, B, C, D, E, F, a, b, c, d, e, f, and are put in a bag; a man takes out two cards and puts them back again; again he takes out two cards and puts them back; he then takes out two cards; in how many ways can he do this consistently with taking out a large and small letter each time and with taking out Ff at least once? (1893.)

Solution.—Each capital may be combined with each small letter, hence there are $6\times6=36$ pairs. Conceive these to be written on cards and put in a bag. First suppose the restriction regarding Ff does not exist, then the first dip may produce any one of these 36, the second dip likewise, and the third dip likewise. Hence by our fundamental principle the number of ways of making 3 dips is 36^3. Now suppose the card Ff removed; there would now be 35^2 ways, in none of which Ff could occur; therefore the number of ways of making 3 dips so as always to include an Ff at least once is 36^3-35^2.

Read the chapters on Arithmetical, Geometrical, and Harmonical Progressions, observing specially the type of the series in Art. 473, Tod., or Art. 60, H. K., and immediately work out XXXI. 45, Tod., or V_β. 9, H. K.

Work out from Tod. XXX. 11, 26, 41, 56; XXXI. 2, 11, 18, 42; XXXII. 8, 14; or H. K. IV_α. 6, 20, 25; IV_β. 13, 17, 21; V_α. 10, 18, 21; V_β. 3, 18, 19.

Example.—If $s=n(5n-3)$ for all values of n, find the pth term.

Solution.—In this type of example get particular sums by giving the values 1, 2, 3, etc., to n; thus the sum of 1 term $=1(5-3)=2$; sum of 2 terms $=2(10-3)=14$; sum of 3 terms $=3(15-3)=36$, and so on, from which we infer that the series is $2+12+22+\ldots\ldots$, and therefore $a=2$, and common difference = 10. Hence the pth term is

$$a+(p-1)d=2+(p-1)10=10p-8.$$

Example.—Find the sum of $1 + 3x + 6x^2 + 10x^3 + \ldots\ldots$ to infinity.

Solution.—The type of series in Art. 60, H. K., or Art. 473, Tod., is not one of the three progressions, its characteristic feature being that the quantities in the brackets form an A.P., while the rest form a G.P. Now the student must be prepared to treat a series in the manner shown in the above-mentioned articles. Taking our example (which is not of the above type), let us multiply by x, and subtract and observe the result.

Let $s = 1 + 3x + 6x^2 + 10x^3 + \ldots\ldots$ to infinity;

$sx = \quad x + 3x^2 + 6x^3 + \ldots\ldots$ to infinity;

$\therefore s(1-x) = 1 + 2x + 3x^2 + 4x^3 + \ldots\ldots$ to infinity,

which is of the above type, so multiply again by x, and we get:

$$s(1-x)x = x + 2x^2 + 3x^3 + \ldots\ldots$$

Then $s(1-x) - sx(1-x) = 1 + x + x^2 + x^3 \ldots\ldots$, which is a G.P.

$$= \frac{1}{1-x};$$

$$\therefore s(1-x)(1-x) = \frac{1}{1-x}, \text{ and } s = \frac{1}{(1-x)^2}$$

Trigonometry.

Example 3 of last month.—This ought to have been, 'Prove $r_a r_b = S$, where C is a right angle,' but unfortunately the suffix b was omitted. We give the solution :—

C is a right angle, therefore at once write $c^2 = a^2 + b^2$, and watch for the opportunity to use it.

$$r_a r_b = \frac{S}{s-a} \cdot \frac{S}{s-b} = \frac{S^2}{\frac{b+c-a}{2} \cdot \frac{a+c-b}{2}}$$

$$= \frac{4S^2}{c^2 - a^2 + 2ab - b^2}$$

$$= \frac{4S^2}{2ab} = S, \text{ since } 2ab = 4 \text{ times area.}$$

Note.—Be prepared to use the expressions,

$$\sin\frac{A}{2} = \sqrt{\frac{(s-b)(s-c)}{bc}}, \text{ etc.,}$$

when $\sin\frac{A}{2}$, $\cos\frac{A}{2}$, $\tan\frac{A}{2}$, etc., occur.

Read the articles dealing with the area of a regular polygon, and a particular case of it, namely, a circle; and also the radii of circles inscribed in and circumscribed about a given regular polygon.

Work out :—

6. Find the difference between the areas of a regular octagon and a regular hexagon, if the perimeter of each be 24 feet.

Ans. 1·8866 sq. feet.

7. Compare the areas and perimeters of octagons, which are respectively inscribed in and circumscribed about a given circle, and show that the areas of the inscribed hexagon and octagon are nearly as $\sqrt{27}$ to $\sqrt{32}$.

8. Find expressions for the areas of the regular polygons of n sides, inscribed in and circumscribed about a given circle.

The difference between the perimeters of an inscribed and a circumscribed regular dodecagon equals a; show that the difference between their areas is $\dfrac{a^2}{192\left(1-\cos\frac{\pi}{12}\right)^2}$.

The student should make himself familiar with expression for certain lengths and distances which frequently occur; for example, the distances between the centres of the various circles, inscribed, escribed, and circumscribed. We shall now give a few others :—

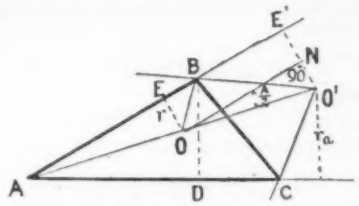
1. $AE = s - a$, $AE^1 = s$, $\therefore EE^1 = a$.

2. $OO_1 = ON \operatorname{cosec}\frac{A}{2} = a \operatorname{cosec}\frac{A}{2}$.

3. $OA = OE \operatorname{cosec}\frac{A}{2} = r \operatorname{cosec}\frac{A}{2}$.

$OA = AE \sec\frac{A}{2} = (s-a)\sec\frac{A}{2}$.

$O_1A = AE^1 \sec\frac{A}{2} = s \sec\frac{A}{2}$.



4. The bisectors OB, O_1B are at right angles, hence a circle will go round OB, O_1C.

5. The perpendicular BD = AB, sin A = c sin A, or a sin C.

Work out :—

9. Prove that $\frac{hkl}{r} = \frac{2abc}{a+b+c}$, where h = OA, k = OB, l = OC in fig. 2.

10. Given a, b, c in Arithmetical Progression, and a the longest side, prove that $6Rr = ac$.

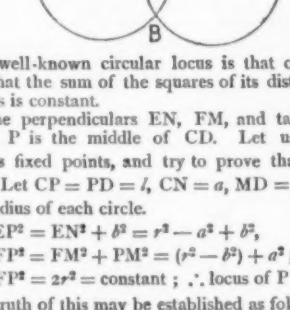
11. If in a triangle tan A = 1, tan B = 2, prove that the product of perpendiculars from the corners on to opposite sides equals $\frac{3}{5}abc$.

12. Prove that $\frac{a^2}{rr_a} = \frac{(r_b + r_c)^2}{r_b r_c}$.

Geometry.

Problems on Loci.—In the appendix to Tod.'s 'Euclid' will be found a few examples of well-known loci, all of which, however, do not bear on the first three books. A better collection of simple loci will be found in the addenda to Book III. in Nixon's 'Euclid Revised,' and the student must furnish himself with such a set.

Solution to Ex. 1.—Examine first for symmetry. It is clear that whatever the path of the middle point P of CD is, the two parts of it above and below EF are equal, 'also there will be symmetry' with respect to the line AB. This suggests that the locus will not be a single straight line. Now examine for particular points. A and B are evidently particular points, for CD may be parallel to EF. By taking a few positions of CD fairly close to each other, we shall be led to *expect* that the required locus is not a straight line; therefore let us try to prove that it is a circle.



Now a well-known circular locus is that of a point which moves so that the sum of the squares of its distances from two fixed points is constant.

Draw the perpendiculars EN, FM, and take NP equal to AM, then P is the middle of CD. Let us now consider E and F as fixed points, and try to prove that $EP^2 + FP^2$ is constant. Let CP = PD = l, CN = a, MD = b, $\therefore a + b = l$, also r = radius of each circle.

Then $EP^2 = EN^2 + b^2 = r^2 - a^2 + b^2$,

$FP^2 = FM^2 + PM^2 = (r^2 - b^2) + a^2$;

$\therefore EP^2 + FP^2 = 2r^2 =$ constant; $\therefore$ locus of P is a circle.

Note.—The truth of this may be established as follows :—

Let O be the middle of EF, then by a well-known rider,

$EP^2 + FP^2 = 2EO^2 + 2PO^2$;

$\therefore PO^2 = \frac{1}{2}(EP^2 + FP^2) - EO^2 =$ constant;

therefore P moves in a circle with O as centre, and since A is a particular point on the locus, then OA is the radius of this circle.

Ex. 2 may be worked by Prop. 32, Book III.

Work out the two following riders :—

3. On the same chord, and on the same side of it, two arcs of circles are described, each greater than a semicircle; show how to draw through one end of the chord a straight line cutting both the arcs, and such that its segment between them is the greatest possible.

4. Let ACP be a triangle, having the angle ACP bisected by a straight line which meets AP in D; describe a circle about ACD, and in its circumference take points B and E, so that ABCDE are in order; show that the angle at P equals the difference between the angles in the segments ABC and DEA.

SCIENCE JOTTINGS.

IN June last a tornado passed north-eastward through three counties in Eastern Oregon. During the progress of the tornado at Long Creek, a piano was taken up and carried one hundred yards.

* * * * *

THERE is clear evidence that damage by lightning has increased during the past few years. The increase is attributed to the employment of electricity in various industries, the continual change of the form of the earth's surface by deforestation, drainage, etc., and the impurities introduced into the atmosphere by the growing consumption of coal.

* * * * *

A DISCUSSION of the rate of motion of Encke's comet, which occasionally passes near Mercury, has been made by Dr. Backlund, with the object of determining the planet's mass. The result indicates that 9,700,000 planets like Mercury would be required to make up the mass of the sun. This is a much smaller mass than has hitherto been ascribed to the planet.

* * * * *

IN an address delivered before the American Association for the Advancement of Science this year, Prof. Harkness said that a careful consideration of all the trustworthy observations of solar parallax leads to the conclusion that the mean distance between the earth and sun is 92,797,000 miles, with a probable error of 59,700 miles, and the diameter of the solar system, measured to its outermost member, the planet Neptune, is 5,578,400,000.

* * * * *

NEWTON estimates in his 'Principia' that two spheres of the density of the earth, each a foot in diameter, would, if separated a quarter of an inch, and left to their own attractions, take nearly a month to come into contact. Prof. Poynting shows, however, in his recently-published essay on 'The Mean Density of the Earth,' that there is a mistake in the arithmetic, and that in reality the spheres would come into contact in between five and six minutes.

* * * * *

ACCORDING to a paper by Dr. Buchan, in the 'Journal of the Scottish Agricultural Society,' the driest region in Scotland is the low-lying district round the Moray Firth, the mean annual rainfall there being about twenty-four inches. The three wettest regions are the south-eastern half of Skye, with a mean annual rainfall of more than eighty inches; the central parts of Rossshire and Invernessshire, and the north of Argyll, with an average of about one hundred inches; and to the south-east of the Caledonian Canal, the average at Glencoe amounting to nearly one hundred and thirty inches per annum.

* * * * *

AT a recent meeting of the Royal Botanic Society of London some curious carpels of a local Mexican tree were exhibited under the name of 'jumping beans.' They are about the size of large cherry-stones, of a triangular form, with two flat and one convex surfaces, and contain the larvæ of a peculiar moth, *carpocapsa saltans*, which by its vigorous action inside the seed-vessel causes it, when placed upon a flat surface, to hop about in a most curious manner. There is no opening of any kind in the shell of the seed-vessel, and the larvæ appear to have been produced in like manner as that of our common apple or codlin moth (*carpocapsa pomonella*), the moth laying its egg inside the young fruit.

* * * * *

THE observatory which Dr. Janssen has been the means of instituting near the summit of Mont Blanc, has lately received an important addition to its equipment. It being practically impossible to keep observers at the observatory during the whole winter, an instrument has been designed which will automatically record variations of meteorological phenomena for a period of eight months. This meteorograph, when wound up, will thus run through the winter and spring without requiring any attention. It will register changes of pressure, temperature, moisture, and the direction and velocity of the wind. The question of long-period meteorographs for meteorological stations at high altitudes is so important that the result of the experiment will be awaited with great interest.

MR. C. DAVISON describes in *Nature* some of the results of the disastrous earthquakes which visited Greece last April. He says that the earthquake was a remarkable one in several ways. At the moment of the shock, the sea rose in a wave which submerged the whole coast from the Bay of St. Theologos to St. Constantin. The water afterwards retired, except in the plain of Atalante, where the greater part of the coast is now submerged for a distance of some yards. Several springs have ceased to run, while others have increased their flow. New thermal springs have started at Aedipos, near pre-existing ones, and similar in nature. Numerous fissures, occasionally some miles in length, have been formed. But the most remarkable phenomenon of all is the production of a great fissure more than thirty miles long. Its breadth varies from an inch or so to a little over three yards, according to the nature of the ground, being on an average about eighteen inches. It extends in a constant east-south-east and west-north-west direction from the Bay of Scroponeri through Atalante, until it disappears near St. Constantin.

* * * * *

THE meteorological results for the six months from April to September of this year are discussed by Mr. C. Harding in *Nature*. They go to show how the several elements of temperature, rainfall, and sunshine combine to make up what is commonly called weather, and how, in the case of the past summer, the absence of sunshine can mar the season. The mean maximum temperature was below the average, except in April, while the mean minimum temperature was in excess of the average, except in May and September. Though rain fell with great frequency, the amount was by no means excessive, and, with the exception of July and August, the monthly rainfalls were below the average. The amount of sunshine, however, was very largely deficient; in fact, this was the principal feature of the period, the sun being screened by clouds far more than usual throughout the summer. The frequency of rain was in excess of the average, except in parts of Scotland, and the amount of rain was in excess, except over the northern portion of the kingdom and in the Midland Counties, the total rainfall for the summer in the latter district being two inches short of the average.

* * * * *

A NUMBER of researches on the germination of seeds have recently been made. The late Dr. Romanes carried out a series of experiments for the purpose of determining the extent to which the power of germination of dry seeds is affected by preventing their respiration for long periods. To this end (says *Science Gossip*) they were sealed in vacuum-tubes of high exhaustion (one-millioneth of an atmosphere) for three months, and then transferred for a period of twelve months to other tubes containing pure gases or vapours (carbon dioxide, nitrogen, chloroform, etc.). In no case was their power of germination deteriorated to any considerable extent. M. R. Pictet states that many seeds may be exposed, when dry, to a temperature of 200 degrees, without in the least injuring their vital activity. Similar results were obtained with various bacteria. According to M. C. Chauveaud, the germination of grape seeds can be greatly accelerated by removing the hard integument of the beak. This is the result partly of allowing free entrance of water to the embryo, partly of the removal of the mechanical obstacle to the emergence of the radicle. Mr. H. H. Dixon has proved by experiment the incorrectness of the assertion that the presence of bacteria is essential to the germination of seeds.

MAGNETISM AND ELECTRICITY.

FOR THE ADVANCED STAGE OF THE SCIENCE AND ART DEPARTMENT COURSE.

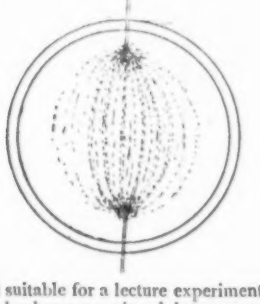
BY EDWIN EDSER, A.R.C.S.

Assistant in the Physical Laboratory, Royal College of Science; Member of the Physical Society.

IN our last month's contribution we considered a *mathematical* method of determining the lines of force due to given charges placed in definite positions. It now remains to be explained how these lines of force may be experimentally demonstrated.

It is probably known to the student that if a card or a piece of glass be placed above a permanent magnet, and iron filings be dusted over it, the filings will arrange themselves in long lines radiating from one pole, curling round, and eventually converging towards the other pole. These show the course of the *lines of Magnetic Force*; and the question arises, can a similar method be devised to display the lines of Electric Force?

The following method may be used for this purpose. A glass vessel, partly filled with ether, has two small knobs, connected with the two terminals of an electric machine, placed near its lower surface. If now the machine be worked, lines of force will radiate from one knob and converge on the other; and if some finely powdered sulphide of antimony be dusted into the vessel, the small particles will arrange themselves along these lines, as the iron filings did in the case of the magnet. To obtain the best result, the connections should be repeatedly reversed, as the particles are attracted more strongly to one pole than the other. The appearance presented is shown in Fig. 1.



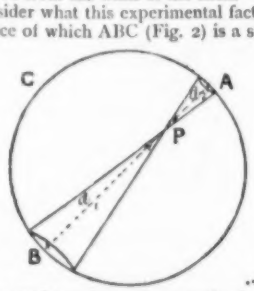
Another method suitable for a lecture experiment is as follows:—Two large insulated spheres are placed between a strong source of light and a white screen, so that their shadow will be thrown on the latter. If now two small pith balls, mounted on opposite ends of a small piece of wire, be free to turn, and be brought near one of the insulated spheres (both supposed charged), it will set itself along the lines of force. Beginning now near one of the spheres, we can draw a line on the screen over the shadow of the wire; and then moving the wire with the pith balls, so that its shadow commences where the line we have drawn terminates, another element of the line of force can be drawn, and so on, till the line approaches the other sphere. The student should compare this *experimental* method with the mathematical one discussed last month.

For the convenience of those teaching science, the following details of this experiment are given:—The piece of wire should be just so thick as not to bend under the weight of the pith balls, which are pushed on its ends. A small hole is made in the middle of the wire by hammering a needle through it, or otherwise; to render this easier, the wire may be slightly flattened at this point. A thin fibre of cocoon-silk is now threaded through this hole, and the ends of the silk attached to a small bow made from a thin piece of whalebone. Drops of shellac are allowed to harden, one a millimetre above the other, at the centre of the fibre, the pierced wire being placed in position between them. Holding the whalebone bow in the hand, the pith balls, which are perfectly free to rotate, may be moved to any position of the field as required for the experiment.

Law of the Inverse Square.—The importance of this law renders a further proof of its truth than that obtained from experiments with Coulomb's torsion balance interesting.

If an insulated hollow shell of any shape be charged with electricity, it has been proved experimentally that there is *no electrical force* in the interior. Thus a charged pith ball or fragment of gold or aluminium placed inside the shell will nowhere be attracted towards, or repelled from the walls of the shell.

Now let us consider what this experimental fact means. Consider the spherical surface of which ABC (Fig. 2) is a section. Take any



point P within the surface; then, since each element of electricity situated on the surface will be acting at the point P, so as (say) to attract the charged fragment of aluminium leaf towards it, the fact that there is no observable attraction, proves that the attractions due to opposite elements of electrified surface must be equal and in opposite directions, so as to cancel each other.

Now imagine a double cone to be described by a straight line which always passes through P, moving so that one end traces out the boundary of a small element of surface at A; then the elements which these cones cut off from the spherical surface can be shown geometrically to be proportional to the square of the distance in each case from the point P. Let these distances be represented by d_1 and d_2. Then, since electricity will be uniformly distributed over the spherical surface, the amount of electricity condensed on each of the above-mentioned elements will be proportional to the area of the element, and therefore to the square of the radius. Also, since the electricity will be of the same kind (*i.e.*, either + or −) all over the surface, one of the forces will be in the direction PA, and the other in the direction PB.

Let us assume that the force at a distance d from a quantity of electricity $= q$, is represented by

$$f = q f(d),$$

where $f(d)$ represents a factor depending for its value on the value of d; then, since the quantity of electricity on each of the elements of surface will equal cd^2 and cd_2^2 respectively, c being some constant, we must have for the forces at P due to the two elements to be equal

$$cd_1^2 f(d_1) = cd_2^2 f(d_2);$$

$$\therefore \frac{f(d_1)}{f(d_2)} = \frac{d_2^2}{d_1^2};$$

$$\therefore f(d_1) = \frac{1}{d_1^2}$$

$$f(d_2) = \frac{1}{d_2^2},$$

i.e., the attraction or repulsion varies inversely with the square of the distance.

Also, since there is no force inside an electrified shell, all points within such a shell will be at the same potential. This fact, it will be noticed, is assumed in Stewart's book (par. 28) when the capacity of a spherical condenser is discussed.

The methods of obtaining an expression for the capacity of spherical and plane condensers given in the above paragraph, should be carefully followed by the student, and the results committed to memory. It must be remembered that a large proportion of the questions in the Advanced Examination papers are of the character of numerical examples. If one of these is worked accurately, full marks will be obtained, so that the benefit of rendering himself thoroughly familiar with such examples becomes immediately apparent to the student. A few sample questions, taken from examination papers in recent years, together with their solutions, are here appended:—

'The inner coatings of one spherical Leyden jar, whose surfaces have radii 12 and 14 respectively, is charged with 25 units of + electricity, and the inner coatings of another, with surfaces of radii 8 and 12, is charged with + 5 units, the outer coatings of both being earth connected; their inner coatings are then momentarily joined by a fine wire: in which direction will electricity pass, the dielectric in both jars being air, and the distance between the jars considerable? Give full reasons for your answer.' (May and June 1894.)

Answer.—Electricity will flow from the coating which is at the higher potential to that at the lower potential.

To determine the potential of the inner coating of either jar, since the outer coatings of both are earthed, and the dielectric is air, we have

$$C = \frac{Q}{V}, \quad \text{where } C = \text{capacity of the condenser},$$
$$Q = \text{quantity of electricity in charge},$$
$$V = \text{potential of inner coating},$$

$$\therefore V = \frac{Q}{C}.$$

Also, capacity of spherical condenser $= C = \frac{R_1 R_2}{R_2 - R_1}$,

where R_1 and R_2 are the radii of the inner and outer coatings respectively.

$$\therefore V = Q \frac{R_2 - R_1}{R_1 R_2},$$

Substituting values for first condenser, we get

$$V_1 = +25 \frac{14 - 12}{14 \times 12} = +\frac{25}{84}.$$

For second condenser

$$V_2 = +5 \frac{12 - 8}{8 \times 12} = +\frac{5}{24}.$$

Reducing to a common denominator we get

$$V_1 = +\frac{50}{168}, \quad V_2 = +\frac{35}{168}.$$

$\therefore$ electricity will flow from the first condenser to the second.

'A sphere of radius 40 millimetres (mm.) is surrounded by a concentric sphere of radius 42 mm., the space between the two being filled with air. What is the relation between the capacity of the system and that of another similar system in which the radii of the spheres are 50 and 52 mm. respectively, and the space between them is filled with paraffin of specific inductive capacity 2·5?' (June 1893.)

Answer.—The capacity of a spherical condenser of radii R_1 and R_2, the space between the coatings being filled with a substance of specific inductive capacity K, $= \frac{KR_1R_2}{R_2 - R_1}$.

Substituting the values given in the question, we have

$$\text{Capacity of first condenser} = \frac{1 \times 4{\cdot}0 \times 4{\cdot}2}{4{\cdot}2 - 4{\cdot}0} = 84,$$

the dimensions being measured in centimetres;

$$\text{Capacity of second condenser} = \frac{2{\cdot}5 \times 5{\cdot}0 \times 5{\cdot}2}{5{\cdot}2 - 5{\cdot}0} = 325.$$

$\therefore$ Capacity of 1st condenser : Capacity of 2nd :: 84 : 325.

'Two equally charged spheres repel each other, when their centres are half a metre apart, with a force equal to the weight of 6 milligrams. What is the charge on each in electro-static units?' (June 1893.)

We have for the force f between two bodies charged with q and q' electro-static units of electricity, at a distance d apart, in a medium of sp. ind. cap. $= k$.

$$f = \frac{1}{k}\,\frac{qq'}{d^2},$$

where f, it must be remembered, is measured in dynes.

Then force corresponding to weight of ·001 gramme

$$= {\cdot}001 \times g = {\cdot}001 \times 981 = {\cdot}981 \text{ dynes.}$$

Assuming the equally charged spheres to be in air, we have $k = 1$, and therefore

$$\cdot 981 = \frac{q^2}{(50)^2},$$

$$\therefore q^2 = {\cdot}981 \times 2500 = 2452{\cdot}5$$

$$\therefore q = \sqrt{2452{\cdot}5} = 45{\cdot}3 \ldots \text{ electro-static units.}$$

The student should finish the reading of Section 1, and work the examples at the end of that section. If this be done carefully and thoroughly no difficulty should be experienced in answering any of the Science and Art questions in the section of Frictional Electricity.

The following questions are appended as exercises for the student:—

(1) Two spheres of radii 3 and 5 centimetres respectively are placed at a distance apart of 10 centimetres, in air. A charge of 10 electro-static units is now communicated to the sphere of 5 cm. radius, the other one being momentarily connected to earth by a copper wire. What will their attraction now be, in dynes?

(2) If the sphere of radius 3 cm. in the previous problem be now moved up to within 5 centimetres of the other one, what work will be done, in ergs?

(3) What important law is proved by the fact that there is no electrical force within a hollow conductor?

Electricity always flows from points of higher to points of lower potential. How do you explain the fact that if a charged ball be introduced into a charged hollow sphere, on touching the latter with the former, and then connecting the ball with an electroscope, it will be found to have given up all its electricity to the spherical shell, whatever the ratios or the kinds of the charges may have been?

(4) An uncharged pith ball is hung by a long insulating fibre close to a plane conducting sheet. If now a charged sphere be brought close to the pith ball, on the opposite side from the conducting sheet, state what will happen, giving full reasons.

PHYSIOLOGY.

The Heart and the Blood.*

The heart, when cut out of the body, still continues to beat, and the transmission of excitation from one cavity to another was experimented on by Paget, although removed completely from the influence of the central nervous system, and the vessels have a somewhat similar power of independent contractility. The alterations produced in the circulation generally and locally by the contractile power of the vessels, and the changes caused in the vessels by the central nervous system, by peripheral stimulation of the nerves, or by variations in the quality of the blood, have formed the subject of a series of researches extending over many years; and though originated, and in many cases entirely conducted, by Ludwig, have appeared to a great extent under the names of his pupils. The starting-point of these investigations was an examination of the changes in the blood as it flowed through isolated organs, with the view of ascertaining in what manner the combustion by which the animal heat is maintained was effected in the body. While keeping up the circulation of blood through the vessels of muscles severed from the body, Ludwig and Sczelkow observed variations in the flow which appeared to indicate contractile power in the vessels themselves. This research was carried on under Ludwig's direction by various of his scholars in succession, Alexander Schmidt, Dogiel, Sadler, myself, Hafiz, Lépine, A. Mosso, von Frey, and Gaskell. Their observations, as well as those of Cohnheim and Gunning, have shown that the muscular fibres of the arterioles, not only in the muscles but throughout the body generally, have a power of independent and sometimes rhythmical contraction and relaxation. Their contractility is, however, controlled by the central nervous system in accordance with the wants of the body generally. For the amount of blood contained in the body is insufficient to fill the whole of the vascular system at once; and when the vessels are fully dilated, as they are after death, we find that nearly the whole of the blood of the body may be contained in the veins alone. It is, therefore, necessary that when one part of the body is receiving a larger supply of blood, another should be receiving a smaller supply; and the functions of the vaso motor centres have been well compared by Ludwig to the turncocks in a great city, who cut off the water supply from one district at the same time they turn it on to another. Thus it is that when the brain is active the feet may get cold, and Mosso has shown this in an exceedingly neat manner by placing a man on a large board delicately balanced at its centre, and demonstrating that whenever the man began to think, the increased supply of blood to his brain caused the head to go down and the heels to rise up. A similar condition was indicated by Mayow, who gave a different explanation. He said that the vital spirits were not able to be in the same place at once, and therefore it happens that if a man eats a heavy meal, he is apt to become drowsy, because the vital spirits descend from the brain to the stomach in order to carry on digestion; and, on the other hand, if a man thinks vigorously after dinner, the vital spirits have to leave the stomach to go to the brain, and consquently digestion is imperfectly performed. If we substitute the word blood for vital spirits, we have an exact expression of present physiological ideas.

As a general rule, the distension of any hollow muscular organ is attended with great pain. How great is the suffering when obstruction of the bowel prevents evacuation of its contents; or when a calculus, in its passage down the gall duct or ureter, forcibly distends their wall. One of the severest tortures of the Middle Ages was to distend the stomach with water, and the Emperor Tiberius could imagine no more awful punishment for those whom he hated than to make them drink wine, and, at the same time, by means of a ligature, to prevent the distended bladder from emptying itself. The heart is no exception to this rule, and distension of its cavities brings on most acute physical suffering. Its inability to empty itself is a question of relative, and not of absolute, power; for a strong heart may be unable to work only against enormously increased resistance in the peripheral arterioles, while the heart, weakened by degeneration, may be unable to empty itself in face of pressure little, if at all, above the normal.

When the contractile power of the heart is not, as it is in health, considerably in excess of the resistance opposed to it in vessels, but only nearly equal to it, a slight increase in the resistance may greatly interfere with the power of the heart to empty itself, and bring on pain varying in amount from slight uneasiness to the most intense agony in angina pectoris. This is, indeed, what we find, for a heart whose nutrition has been weakened by disease of the arteries, and consequent imperfect supply of blood to the cardiac muscle, is unable to meet any increased resistance if this should be offered to it, and pain is at once felt. In such cases, unless they be far advanced, we find, precisely as we might expect, that walking on a level usually causes no pain, but the attempt to ascend even a slight rise, by which the muscles are brought into more active exertion, brings on pain at once. Yet here again we find, as we should expect, that if the patient is able to continue walking, the pain passes off and does not return. These phenomena would be inexplicable were it not for Ludwig's observations on circulation through the muscles, but in the light of these observations everything is made perfectly intelligible. Walking on the flat, by causing no violent exertion of the muscles, produces no mechanical constriction of the vessels, and thus does not increase the blood pressure. The greater exertion of walking up a hill has this effect, but if the patient is able to continue his exertions, the increased dilatation of the vessels—a conse-

* Extracted from the Harveian Oration, on 'Modern Developments of Harvey's Work,' delivered by Dr. T. Lauder Brunton, F.R.S., at the Royal College of Physicians, on October 18.

quence of muscular activity—allows the pressure again to fall, and relieves the pain.

As muscular exertion continues and the vessels of the muscles become dilated, the flow of blood from the arteries into the veins will tend to become much more rapid than usual. The pressure in the arterial system will consequently fall, but that in the veins will become increased, and unless a corresponding dilatation occurs in the pulmonary circulation, blood will tend to accumulate in the right side of the heart, the right ventricle will be unable to empty itself completely, shortness of breath will arise, and even death may occur. At first the right side of the heart is affected, and the apex beat disappears from the normal place and is felt in the epigastrium, but the left ventricle also becomes dilated, though whether this is simply through nervous influence tending to make it act concordantly with the right, or for some other reason, it is at present impossible to say. Severe exertion, even for a few minutes, may produce this condition in healthy persons, and when the exertion is over-continued it may lead to permanent mischief. More especially is this the case in young growing boys, and it is not merely foolish, it is wicked to insist upon boys engaging in games or contests which demand a long-continued over-exertion of the heart, such as enforced races and paper-chases extending over several miles. Intermittent exertion, either of a single muscle or of a group of muscles, or of the whole body, appears to lead to better nutrition and increased strength and hypertrophy, but over-exertion, especially if it continues, leads to impaired nutrition, weakness, and atrophy. If we watch the movements of young animals, we find that they are often rapid, but fitful and irregular and varied in character, instead of being steady, regular, and uniform. They are the movements of the butterfly, and not of the bee. The varied plays of childhood, the gambols of the lamb, and the frisking of the colt, are all well adapted to increase the strength of the body without doing it any injury; but if the colt, instead of being allowed to frisk at its own free will, is put in harness, or ridden in races, the energy which ought to have gone to growth is used up by the work, its nutrition is affected, its powers diminished, and its life is shortened. The rules which have been arrived at by the breeders of horses ought to be carefully considered by the teachers of schools, and by the medical advisers who superintend the pupils.

In youth and middle age every organ of the body is adapted for doing more work than it is usually called upon to do. Every organ can, as it is usually termed, make a spurt if required; but as old age comes on this capacity disappears, the tissues become less elastic, the arteries become more rigid and less capable of dilating and allowing freer flow of blood to any part, whether it be the intestine, the skin, the brain, the muscles, or the heart itself. Mere rigidity of the arteries supplying the muscles of the heart will lessen the power of extra exertion, but if the vessels be not only rigid, but diminished in calibre, the muscles of the limbs, and the heart itself, will be unfit even for their ordinary work, and will tend to fail on the slightest over-exertion.

How important an effect the excessive admixture of the juices from one part of the animal body with the circulating blood might have, was shown in the most striking way by Wooldridge. He found that the juice of the thyroid gland, though it is harmless while it remains in the gland, and is probably useful when it enters the blood in small quantities in the ordinary course of daily life, yet if injected into the blood, will cause it to coagulate almost instantaneously and kill the animal as quickly as a rifle bullet. What is powerful for harm is, likewise, powerful for good in these cases, and the administration of thyroid juice in cases of myxœdema is one of the most remarkable therapeutic discoveries of modern times. Since the introduction by Corvisart of pepsine as a remedy in dyspepsia, digestive ferments have been largely employed to assist the stomach and intestine in the performance of their functions, but very little has been done until lately in the way of modifying tissue changes in the body by the introduction of ferments derived from solid organs. For ages back savages have eaten the raw hearts and other organs of the animals which they have killed, or the enemies they have conquered, under the belief that they would thereby obtain increased vigour or courage; but the first definite attempt to cure a disease by supplying a ferment from a solid non-glandular organ of the body was made in Harvey's own hospital by the use of raw meat in diabetes. It was not, however, until Brown-Séquard recommended the use of testicular extract, that the attention of the profession became attracted to the use of extracts of solid organs. Since then extract of thyroid, extract of kidney, extract of supra renal capsule have been employed; but even yet they are only upon their trial, and the limits of their utility have not yet been definitely ascertained.

But yet another therapeutic method has been recently introduced which bids fair to be of the utmost importance, the treatment of disease by antitoxins. The discovery by Pasteur of the dependence of many diseases upon the presence of minute organisms may be ranked with that of Harvey, both in regard to the far-reaching benefits which it has conferred upon mankind, and for the simplicity of its origin. The germ of all his discoveries was the attempt to answer the apparently useless question: 'Why does a crystal of tartaric acid sometimes crystallise in one form and sometimes in another?' From this germ sprung his discovery of the nature of yeast and of those microbes which originate fermentation, putrefaction, and disease. These minute organisms, far removed from man as they are in their structure and place in nature, appear in some respects to resemble him in the processes of their growth and nutrition. They seem, indeed, to have the power of splitting up inactive bodies into substances having a great physiological or chemical activity. From grape sugar, which is comparatively inert, they produce carbonic acid and alcohol, both of which have a powerful physiological action. From inert albumen they produce albumoses having a most powerful toxic action, and to the poisonous properties of these substances attention was for a while alone directed. But it would appear that at the same time they produce poisons they also form antidotes, and when cultivated without the body, and introduced into the living organism, they give rise to the production of these antidotes in still greater quantity.

The plan of protection from infective diseases, which was first employed by Jenner in small-pox, is now being extended to many other diseases, and the protective substances which are formed in the body, and their mode of action, are being carefully investigated. The introduction either of pathogenic microbes or of toxic products appears to excite in the body a process of tissue change by which antitoxins are produced, and these may be employed either for the purpose of protection or cure. By the use of antitoxins, tetanus and diphtheria appear to be deprived of much of their terrible power. But it seems probable that a similar result may be obtained by the introduction of certain tissue juices into the general circulation. It was shown by Wooldridge that thyroid juice has a power of destroying anthrax poison, and it seems probable that increase of the circulation of certain organs will increase their tissue activity, will throw their juices or the products of their functional activity into the general circulation, and thus influence the invasion or progress of disease. We are able to influence the circulation in muscles both by voluntary exertion and by passive massage, and we should expect that both of these measures would influence the constituents of the blood generally; and such, indeed, appears to be the case, for J. K. Mitchell has found that after massage the number of blood corpuscles in the circulation is very considerably increased.

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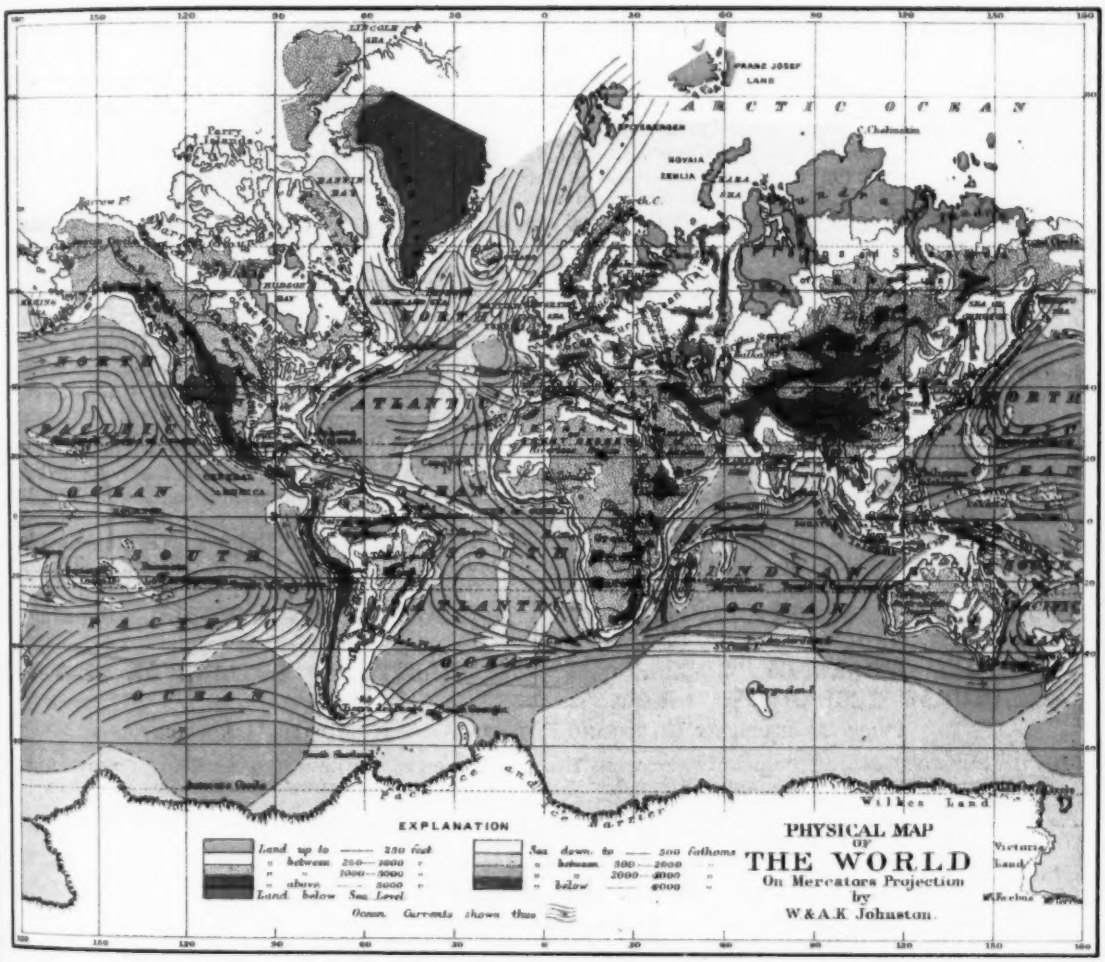
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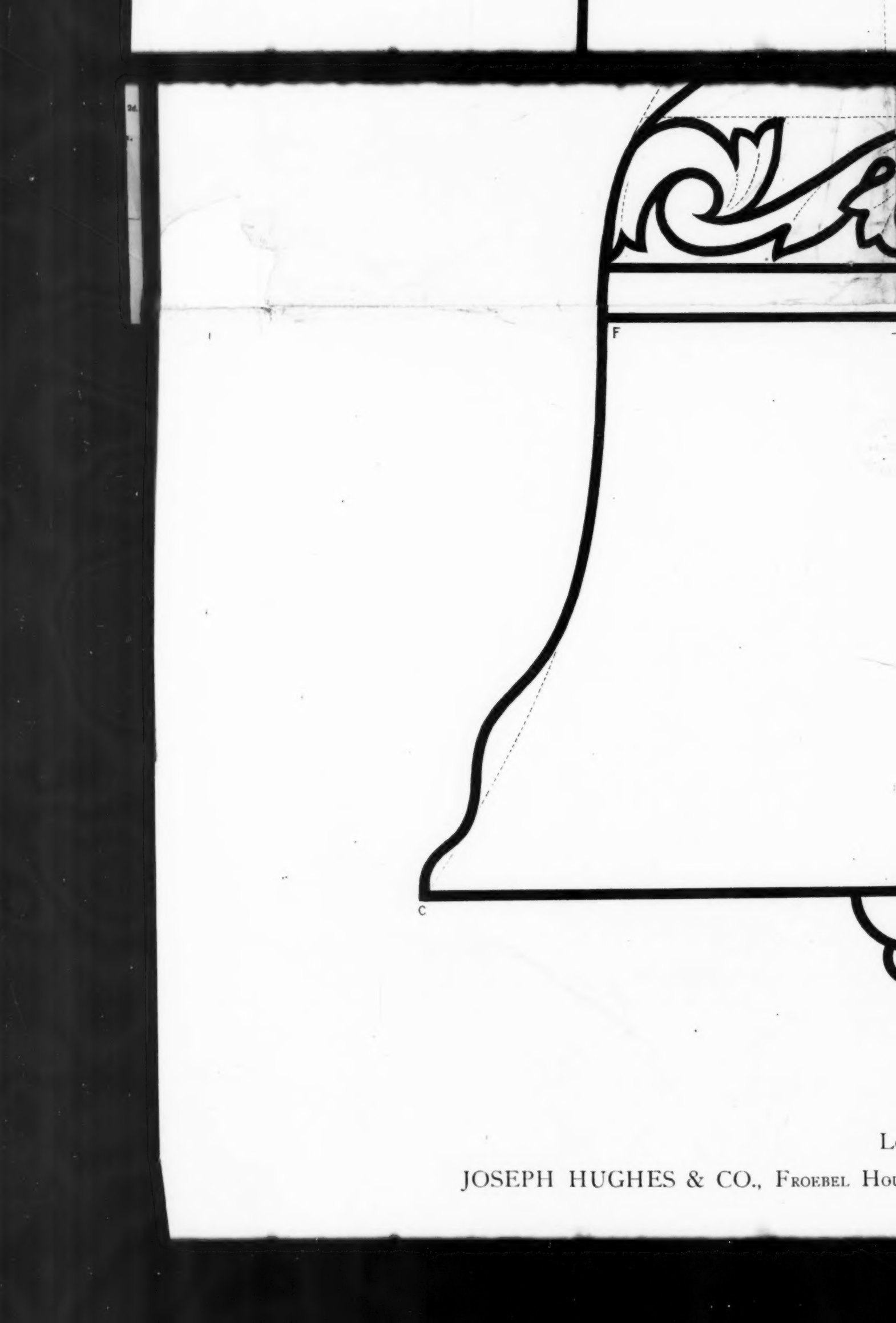
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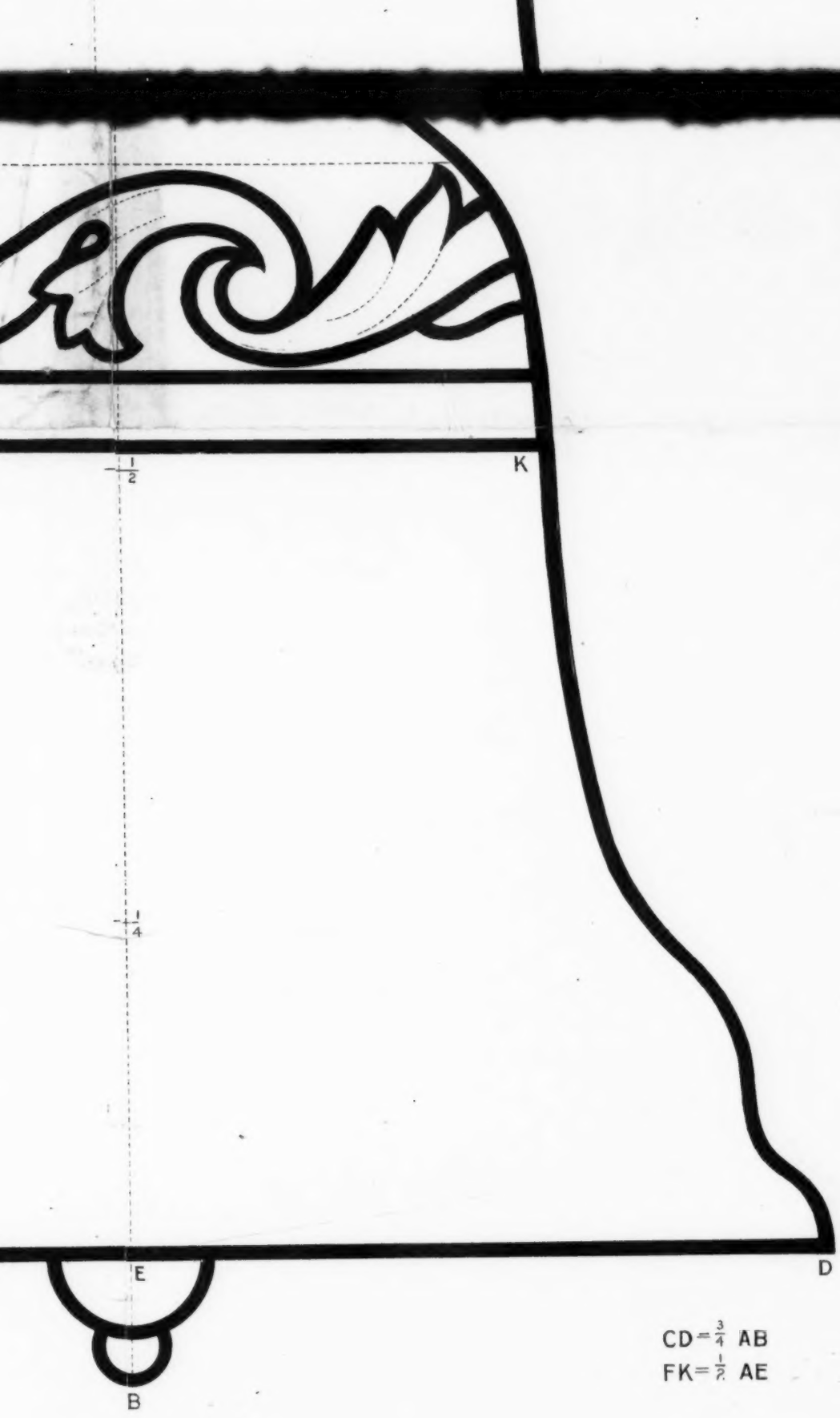

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B.

I said to him I had not got fifteen—eleven and ninepence was everything I possessed, and at last, in my eagerness, I nearly burst into tears. I really do not know if the old man was sorry for me, or if he only thought of getting my money; however that may have been, he took my purse out of my hand and slowly counted out the money.

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